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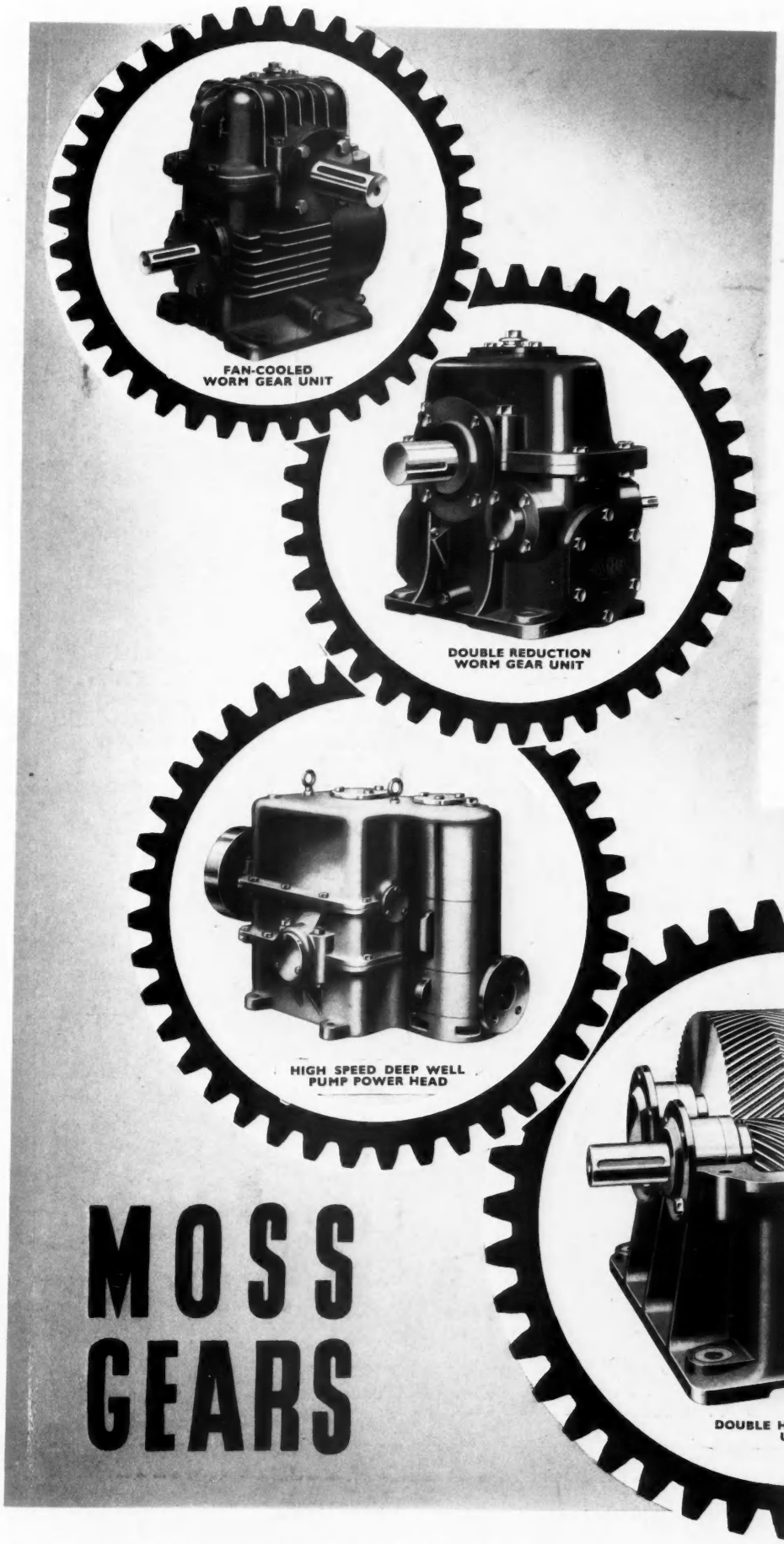
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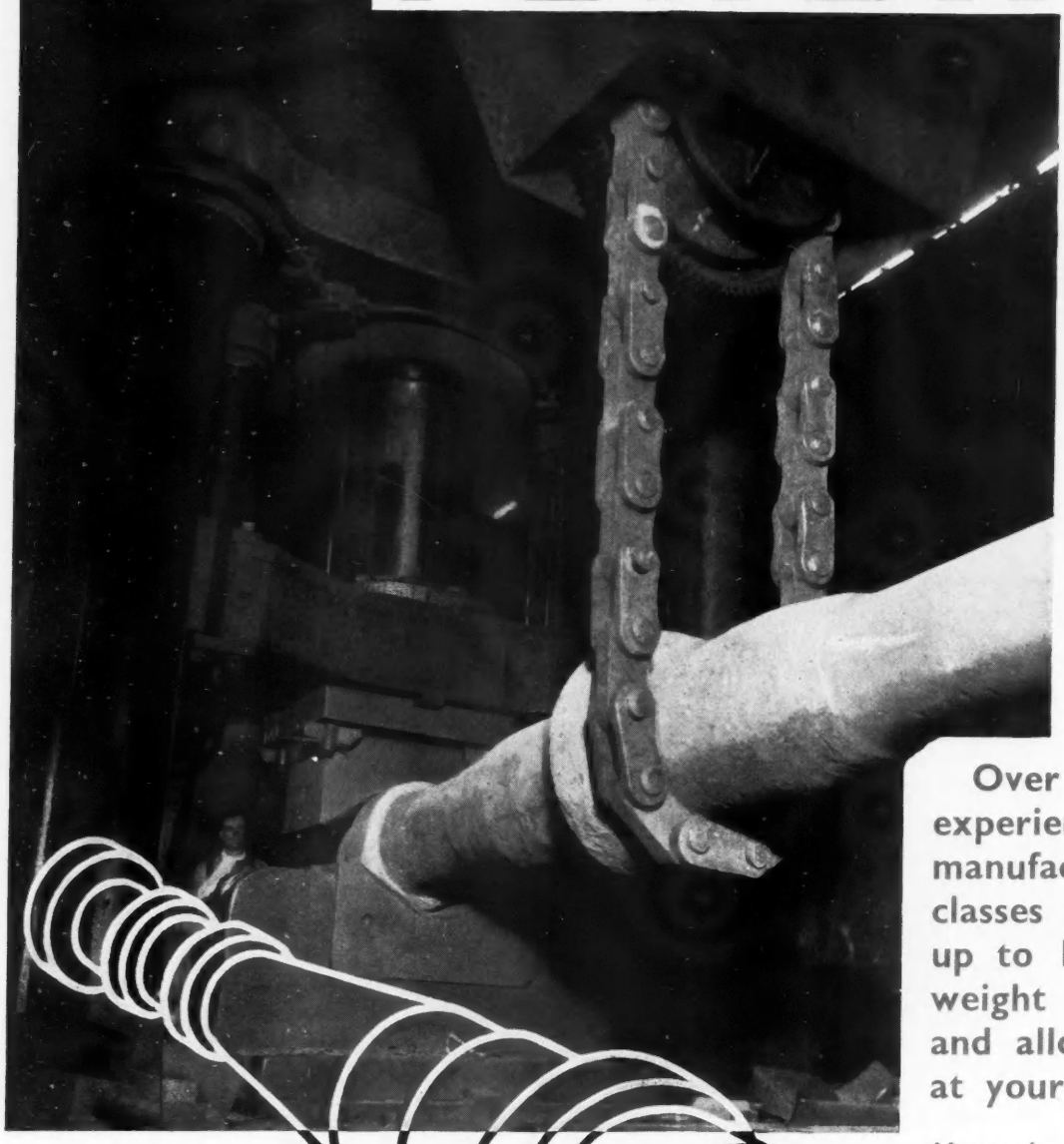

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A Seven-Day Journal

The Vitry Locomotive Testing Station.

ON Wednesday, April 17th, Monsieur Pierre Place, engineer-in-chief at the Vitry locomotive-testing station, gave a paper before the Institution of Locomotive Engineers on the testing of locomotives, and exhibited a very remarkable film which showed in a popular technical way the operation of the Vitry plant. That plant, he said, had already been used for the examination of sixteen locomotives —including "Cock o' the North"—and enough experience had been gained to say that it completely fulfilled the purpose of its designers and builders. If another plant had to be constructed the same principles would be followed, and any alterations which might be made would affect details only. Monsieur Place pointed out that whereas stationary engines, turbines, oil engines, the hulls of ships, the forms of propellers, and so on, could all be tested or examined scientifically, and the results ascertained with a high degree of accuracy, the only method commonly in use for testing locomotives was to put them on the road. That method left much to be desired from the technical aspect, and the lack of certainty about the result left room for the existence of diverse opinions. A properly constituted and operated locomotive testing plant removed those disadvantages and placed the testing of locomotives on the same level as the testing of other power plants. As an example of what is being achieved at Vitry a diagram of a test of an Est locomotive was pinned all round the walls of the Hall of the Institution of Mechanical Engineers, in which the lecture, under the presidency of Mr. H. N. Gresley, was delivered. The film is a most ingenious affair. There are shown, alternately, working diagrams of the essential parts of the plant and moving pictures of the parts themselves. By means of cartouches and living arrows, which flit here and there, the parts are named and pointed out and their functions indicated. The film is "silent," but so ingeniously is it devised that it speaks for itself. There was an exceptionally large meeting at the Institution of Locomotive Engineers last week, but it is to be hoped that means of showing the film to an even larger audience may be found. For the convenience of our readers we may add that the Vitry plant was described in our issue of November 10th, 1933.

The National Electrical Convention.

NEARLY 3000 delegates drawn from all parts of the kingdom and constituting the largest gathering of leaders of any industry in this country are taking part in the National Electrical Convention to be held at Bournemouth from June 3rd to 8th. At a luncheon held at the Savoy Hotel, London, on Tuesday, April 16th, Viscount Elibank explained to representatives of the daily and technical Press the objects of the Convention and the beneficial effects it is expected to have upon the industry. In referring to the grid, Viscount Elibank said that although it was in its infancy, he believed that under the efficient guidance and direction of its present Board, formed as it was of gentlemen eminent in the commercial and electrical engineering world, it was justifying its existance, but it was essential that it should continue to ensure an ever-cheapening of power at standard voltage. While the grid legislation was of a socialistic nature, it was so framed that it was the happy mean between what might be termed capitalism and socialism. It was desired that it should be a living monument to the convictions of far-sighted pioneers, such as Sir John Snell, Sir Andrew Duncan, and Sir Archibald Page. National Electrical Conventions, such as that which was to be held in June, would help in securing that result, and in ensuring the permanence of the grid as an instrument of public good. Undoubtedly the present time was a critical period in the development of the industry, and the responsibility of the delegates who would gather at Bournemouth would be proportionally heavy.

A French Anti-Noise Competition.

A COMPETITION will take place shortly at the Test Laboratory of the Conservatoire National des Arts et Métiers in Paris to provide the best sound-proof materials for use in the construction of dwelling-houses. The Touring Club of France, which for the last five years has been waging war on excessive noise and has of late been particularly concerned with the noise produced by the motor cycle, is organising in collaboration with the technical staff of the French Automobile Club a big test of silent apparatus for use in the interior of dwellings. During 1932–33 the Club sponsored a series of tests on building materials at the Test Laboratory of the Conservatoire National des Arts et Métiers under the direction of Monsieur J. F. Cellerier, the head of the Laboratory, in order to obtain figures for the sound-carrying properties of materials. As a result of the tests made, numerous sound-insulating materials have been placed on the market. This year the Club will offer cash prizes for the best of such materials, the winning materials to be used in the construction of a demonstration house at the 1936 Salon des Arts Ménagers. The competition will take place in June, and will comprise three events. First, elimination trials at the Laboratory of the Conservatoire National des Arts et Métiers, the materials being tested both for sound transmission and for sound reflection, while account will be taken of the appearance of the material in finished form. Secondly, the construction of rooms out of the materials selected in the Salon des Arts Ménagers, 1936, as a public demonstration of their proper utilisation. Finally, since other sources of noise exist in the home, such as the slamming of doors, the noise of running water caused by filling and emptying baths, &c., noise from the central heating apparatus, the noise of lift operation, and the sound of electric contactors, &c., the Club proposes to add a third class to the competition to cover apparatus of these descriptions. The rules of the competition are now being prepared, and those interested may obtain copies by request after May 15th from the Touring Club de France, 65, Avenue de la Grande Armée, Paris.

Less Idle Shipping.

THE quarterly returns prepared by the Chamber of Shipping of the United Kingdom of the tonnage laid up at the Ports of Great Britain and Ireland on April 1st show that there were at that date 322 vessels of 705,699 net tons laid up, corresponding to 1,184,750 gross tons. Compared with the returns for January 1st, there was a decrease of 172,717 net tons, or 19·7 per cent., while compared with the corresponding figures for April 1st of last year a decrease of 373,322 tons net, or 34·6 per cent., is recorded. The ports at which the largest reductions occurred were London (Docks), with a decline of 106,000 tons net; Liverpool, 45,000 tons; Tollesbury 29,000 tons; the river Fal, 29,000 tons, and Dartmouth, 10,000 tons. There were increases at Newcastle of 32,000, at Swansea of 19,000 tons, and at Cardiff of 12,000 tons net. The Chamber further states that the net change in the total tonnage on the United Kingdom Register during the first three months of this year resulting, on the one side of the account, from new construction, and, on the other, from sales to British and foreign ship-breakers and transfers to foreign flags, has been a reduction of about 180,000 tons gross. It points out that as the idle tonnage decreased during the period by 286,000 tons gross, there must have been an increase of about 106,000 tons gross in the tonnage in commission of vessels on the United Kingdom Register. If allowance be made for the recent withdrawal from service of the "Mauretania," the improvement in the amount of tonnage commissioned is reduced to about 75,000 tons gross.

The Shipwrights' Company.

AT a meeting of the Court of the Worshipful Company of Shipwrights, which was held at the Barbers' Hall, on Thursday, April 18th, the Duke of York, the permanent Master, presided, and presented medals to the winners in the recent examination in naval architecture. The Duke installed Sir Charles Barrie as second Master, and the following as Wardens:—Sir William Berry, Upper Warden; Sir Edward Nicholl, Second Warden; Sir Percival Clarke, Third Warden; and Mr. John Weir, Fourth Warden. Sir Archibald Denny, who introduced the winners of the Company's medals at the recent examination in naval architecture, recalled that it was the Department of Science and Art which established the training by evening classes of naval architects, and also established the practice of having a medals examination. That annual examination was carried out without interruption until the war, but ceased in 1918. The Company, he said, had now restored the examination. The successful candidates were Mr. W. Walker, of Dumbarton, and Mr. J. Forsyth, of Sunderland, gold medals; Mr. J. Cook, of Newcastle, silver medal; and Mr. T. Naisby, of Sunderland, bronze medal. The Duke of York then presented the medals, and subsequently presided at the Court luncheon.

Workman Clark (1928), Ltd.

ON Saturday, April 20th, an authoritative announcement was made in Belfast to the effect that the shipyards of Workman Clark (1928), Ltd., had been acquired by National Shipbuilders Security, Ltd., and will be shortly closed down. The negotiations with regard to the sale of the yards have been going on for some time, and although the main points are now settled there are still certain details to be decided. While the passing of such an old-established firm of engineers and shipbuilders is to be regretted, it is satisfactory to learn that some of the works will pass into other hands, and that at others a new aircraft construction business may be developed. The South yard of the Workman Clark undertaking has been acquired by Harland and Wolff, Ltd., and will be used mainly to permit that firm to make extensions to its existing engine shops. It is hoped that the site on which the North yard stands may be secured by a new company which is now being formed for the building of aeroplanes. Such an industry would be new to the North of Ireland, and the project has a good backing, the site being an ideal one for the construction of aircraft of all kinds. During the past six months there has been no ship on the stocks and the staff has been gradually reduced as the work in hand has been completed, many of the men having found work with Harland and Wolff or on the Clyde and Tyne. The firm of Workman Clark was founded by the late Sir George Clark and Mr. Frank Workman in 1880, and famous ships of all kinds have been built and engined by it.

Rural Water Supplies,

ON Thursday, April 18th, on the motion for the adjournment of the House of Commons for the Easter recess, several important questions were asked concerning the country's water supplies. In his reply, Mr. Shakespeare, the Parliamentary Secretary to the Ministry of Health, said that the Ministry's policy of last year had weathered the worst drought in history, without any hardship being suffered in any urban area. The supplies during the past six months had, he said, been above the normal, and the reservoirs were now full. The Government measures were well on the way to break the back of the problem, and the future could be looked to without apprehension. Speaking on rural water supplies, Mr. Shakespeare said that schemes for which grants had been allocated had already reached a capital value of £3,200,000 in 1100 parishes. In addition, about £500,000 in loans had been sanctioned in respect of 200 more parishes. The actual payments in grants allocated and loans made amounted to £3,700,000 in a year, though the average for the last ten years had been only £425,000. Schemes had already been prepared in respect of 1600 of the 2000 parishes which were in need of permanent supplies, and those parishes would have a permanent supply in the course of a year or two. A strong Water Survey Committee was appointed early in the year and two meetings had already taken place. The Committee would issue an annual report, and no doubt from time to time statistics with regard to particular rivers would become available. With regard to the continuation of emergency powers, if there should be another summer of exceptional drought, it might be necessary to ask Parliament for another extension, but, on the whole, he was of the opinion that the emergency powers would lapse this year, as they had proved their usefulness.

The Armament Trade Inquiry.

IN a Journal note of February 22nd we gave the composition and terms of reference of the Royal Commission appointed to inquire into the private manufacture of and trading in arms. The announcement is now made that the first public meeting of the Commission for hearing evidence will take place on Wednesday, May 1st, at the Middlesex Guildhall, Westminster. Evidence will be submitted on behalf of the League of Nations Union and, if necessary, the hearing of this evidence will be continued on Friday, May 3rd. The Royal Commission will be glad if intending witnesses who are not already in touch with the Commission will communicate with the secretary at 8, Buckingham-gate, London, S.W.1, without delay.

A New Thames Fire Float.

AT the week-end representatives of the London County Council accepted delivery of a new fire-fighting vessel for use on the Thames. No ceremony took place, and the vessel will shortly proceed to her duties. The "Massey Shaw," as she is named, is a 78ft. twin-screw boat, built by J. S. White and Co., Ltd., of Cowes, under the supervision of Lloyd's Register of Shipping. The Board of Trade requirements and those of the Port of London Authority have also been complied with, so that she should be fully capable of meeting any demands made on her. The description furnished by Major C. C. B. Morris, Chief Officer of the London Fire Brigade, shows that the "Massey-Shaw" is propelled by two eight-cylinder, 160 h.p. Gleniffer oil engines, which give her a speed of about 12 knots. Her hull, a model for which was thoroughly tested for form and for freedom from wash at the National Physical Laboratory, is of steel construction, and is divided into five water-tight compartments. Accommodation is provided for eight men to live aboard, and for the storing of hoses, &c. Two main fire pumps have been supplied by Merryweather and Sons, Ltd., Greenwich, and are of the turbine type, each being designed to deliver 1200 gallons a minute at 125 lb. per square inch pressure, and to be capable of working in series or parallel with the other. On each side of the deck swivelling discharge boxes enable eight 3½in. hoses to be used. There is also a monitor traversing through the whole 360 deg., which can be elevated up to 90 deg., which, with the assistance of the auxiliary pumps, will discharge 2800 gallons per minute at 841 lb. per square inch, with a 3½in. nozzle.

Craigavon Bridge, Londonderry, Northern Ireland.*

No. 1.

THE historic City of Londonderry stands on both banks of the river Foyle at a distance of about 20 miles from the sea, and the river at the City is approximately 860ft. in width between banks, and has a greatest depth below H.W.O.S.T. of about 40ft., with a tidal range of some 7ft. 6in.

Before the year 1790 the only means of communication between the two parts of the City on either side of the river was afforded by a ferry, but in that year a timber bridge was constructed by Messrs. Cox and Thompson, of Boston, New England, at a cost of some £16,600, and was opened to public use.

Early in the nineteenth century it had become apparent that this structure was no longer adequate for the requirements of the community, and Mr. John Rennie, in 1807, and Messrs. G. and J. Rennie, in 1831, furnished plans to the Corporation of the City for bridges with stone or cast iron arches, and for a suspension bridge of 670ft. span with towers of great height. Again, in 1851, the Trustees of Londonderry Bridge retained the services of Sir William Cubitt, F.R.S., M. Inst. C.E., as consulting engineer to report upon the question of a new bridge across the river. These schemes did not materialise, but in 1856 prizes were offered for the two best plans for a bridge at a cost not to exceed £80,000. As a result of this competition, Carlisle Bridge—the predecessor of the bridge forming the subject of this article—was constructed by Mr. John Hawkshaw, M. Inst. C.E., at a cost of £64,500, and was opened for traffic on September 24th, 1863. It was placed about 200 yards up river from the timber bridge, and, on its completion, the latter was demolished.

The general arrangement of Carlisle Bridge will be gathered from Fig. 4, page 438. It was a wrought iron girder bridge of eleven spans, with a total length of about 1180ft. The seven river spans were each of 130ft., and these spans, which sufficed to reach across the river from quay to quay, had upper and lower decks, which accommodated road and rail traffic respectively. The centre span was a swing span for purposes of navigation. The remaining four land spans, each of 60ft. to 70ft., carried the upper deck roadway only over the riverside quays, and, at the City side, over the tracks of the Great Northern Railway Company (Ireland) and over Foyle-road, and terminated at granite-faced abutments. The roadway was 20ft. in width between kerbs, with a footway 5ft. wide on each side. The lower deck carried 5ft. 3in. and 3ft. gauge railway tracks for the transfer of railway goods wagons across the river. The seven river spans were carried on sixteen 11ft. diameter cast iron cylinders sunk in the bed of the river, and, in addition, the centre swing span was carried on a 30ft. diameter cylinder about 10ft. in height, extending downwards to about low-water level, below which it was supported on a group of seven 7ft. diameter cylinders sunk in the river bed. This 30ft. diameter cylinder carried the rollers and track for the swing span, which was operated by hand. All the cylinders were filled with good lime concrete.

The main girders of the seven river spans were of the "N" type, with pin joints, 24ft. apart centre to centre, counterbraced in every panel, and connected in pairs between the upper and lower chords by the upper and lower deck cross girders, the upper deck cross girders cantilevering on each side of the bridge about 3ft. beyond the main girders. The three main girders on each side of the centre swing span were connected at their end posts and formed a continuous girder over these spans. The land span girders were of light lattice construction and were carried on 2ft. diameter hollow cast iron columns. These girders formed the parapet to the roadway, and were connected between their lower flanges by cross girders. The roadway of the upper deck was carried on wrought iron buckled plating supported by the upper deck cross girders, and was of concrete surfaced with wood blocks, with cast iron kerbs and channels, while the footways were of asphalt and concrete flags. The parapet and fascia over the main river spans were of ornamental cast iron, and, at the abutments, the parapets were of granite resting on a bold, bull-nosed granite string course. The lower deck was of timber, which, together with longitudinal timber sleepers under the rails, was carried on the lower deck cross girders. The railway tracks terminated at each end of the lower deck at 17ft. diameter turntables on the quays connecting with the quay railway tracks, and the trains of trucks were hauled across by four electric capstans.

With the advent of modern traffic it became evident that Carlisle Bridge was no longer adequate as to strength or capacity. The narrow width of the roadway caused much congestion, and, in October, 1923, Messrs. Mott, Hay and Anderson, MM. Inst. C.E., were asked to report upon the bridge and upon the question of providing a new bridge conforming with modern standards. Their investigations showed that the girder work of the old bridge was heavily over-stressed. The land span girders, in particular, were dangerously weak, while the upper and lower deck cross girders and the upper deck buckled plating were very unsatisfactory. Furthermore, the whole bridge had suffered much from corrosion as a result of lack of proper maintenance in the past. As a result, it became necessary to afford some immediate support to the land spans by temporary timber trestles with rolled steel joists placed under them, and at the same time to restrict drastically the permitted loading. It was evident that it had become essential either to strengthen and widen the old bridge or to replace it in its entirety by a new structure. Accordingly, in the Londonderry Corporation Act (Northern Ireland), 1924, powers were obtained for the widening and reconstruction of the bridge so as to carry four lines of modern traffic. Various schemes were investigated, but it was finally decided, in July, 1928, by the Ministry of Home Affairs, that the reconstruction of the bridge in this manner would not be economically sound. After having fully investigated the relative merits and demerits of the various schemes, the Government of Northern Ireland decided that it would be more prudent and economical to build an entirely new bridge.

Powers were therefore obtained under the Londonderry Corporation (New Bridge) Act (Northern Ireland), 1929, for the construction of such a bridge, and Messrs. Mott, Hay and Anderson were appointed engineers for the execution of this work. Tenders were invited, and that of Dorman, Long and Co., Ltd., was the lowest at about £255,500, with the shortest contract time at thirty months, and was accepted. Work was started in March, 1931.

The new bridge is generally similar to the old structure, but, as the traffic on the river is not such as to require a swing span, one is not provided. It was placed to the downstream side of Carlisle Bridge and as close to it as the necessity of opening it for traffic before closing Carlisle Bridge for demolition allowed, and it is of the same total length as Carlisle Bridge. Its general arrangement is shown in elevation and in plan in Fig. 1, with a typical cross section through a main river span in Fig. 2. Several general views will be found on page 438.

Craigavon Bridge, as it is called, is of steel, and has twenty-two spans, consisting of five main river spans (Nos. 9–13 inclusive), seven river approach spans (Nos. 5–8 inclusive, and 14–16 inclusive), and ten land approach spans (Nos. 1–4 inclusive, and 17–22 inclusive). The five main river spans are each of 130ft., and the river and land approach spans vary in length between 20ft. and 54ft. Spans Nos. 5 to 16 inclusive extend from quay to quay, and have upper and lower decks for road and rail traffic respectively. The remaining spans cross the quays, certain roads, and the tracks of the Great Northern Railway (Ireland), and carry the upper deck for road traffic only, and terminate at the old abutments of Carlisle Bridge. The roadway of the upper deck is 40ft. in width between kerbs with a footway 10ft. wide on each side, and is thus exactly twice the width of Carlisle Bridge. The lower deck carries 5ft. 3in. and 3ft. gauge railway tracks in the same manner as the lower deck of Carlisle Bridge.

The twelve river spans rest on twenty-four piers in the river. The piers carrying the main river spans, twelve in number (Nos. 8–13 inclusive), each consists of a cast iron skin, 11ft. in external diameter, in quadrant sections, 4ft. deep and 1¼in. thick. These piers, filled with concrete, rest at river bed level on steel cylinders, also concrete filled, 14ft. in diameter at piers No. 8; 20ft. in diameter at piers Nos. 9, 10, 11, and 12; and 18ft. in diameter at piers No. 13. Each cylinder is made up of steel plates, $\frac{5}{16}$in. thick, with a cutting edge plate 14in. by 1in. at the lower end and a coned working chamber 8ft. high, having in its roof plate a hole similar in shape to the air shaft with bolt holes for connection to the air shaft. The concrete filling to the piers and cylinders is of 6 : 3 : 1 mix. The remaining twelve piers (Nos. 5, 6, 7, 14, 15, and 16) carrying the river approach spans are of similar design, but of smaller dimensions generally, the cast iron piers being 5ft. in external diameter, while the steel cylinders are 11ft. in diameter. These twenty-four piers are sited in pairs, and each pair is connected between high and low water levels by suitable steel inter-pier bracings, as shown in Fig. 2. The piers are finished at the top by a cast iron cap of ornamental design.

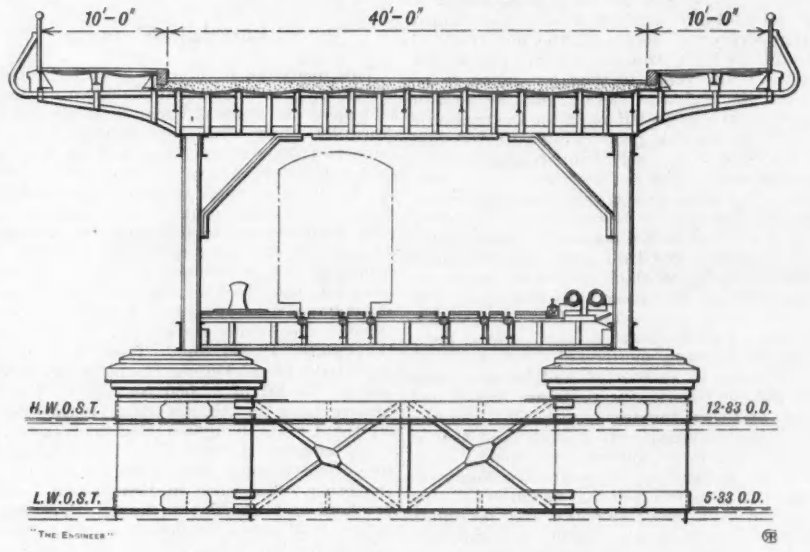


FIG. 2—TYPICAL CROSS SECTION THROUGH RIVER SPAN

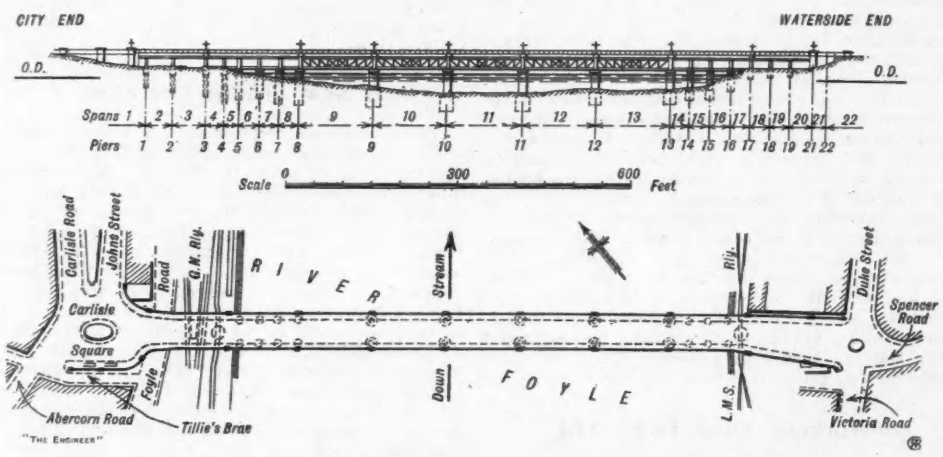


FIG. 1—PLAN AND ELEVATION OF CRAIGAVON BRIDGE

* A short description of this bridge appeared in THE ENGINEER of July 21st, 1933.

The lower strakes of the cylinders with cutting edge, working chamber, and lower lengths of air shaft, were assembled and riveted above high tide level on timber staging constructed in the river at the sites of the cylinders in the manner shown in Fig. 7. When the lower portion of each cylinder was complete it was launched by means of four winches, further strakes of cylinder steel, air shaft, and concrete filling being added to make it sink in the water. The total weight was regulated so that it was some 8 to 10 tons in excess of the buoyancy at low tide. When this condition was reached, the cylinder was pitched in its correct position by winches. This work was necessarily done at low tide, and immediately the cylinder was passed as being in its correct position concrete was added so that it might not rise by buoyancy on the incoming tide. After sufficient weight had been added to counteract the effect of buoyancy, even with air on, the air lock was placed in position.

Compressed air was supplied by a group of three Broom and Wade two-cylinder stationary compressors, each capable of delivering 300 cubic feet of free air per minute at a pressure of 100 lb. per square inch.

When a cylinder reached its final level the working chamber was concreted with a 6 : 3 : 1 mix and grouted, both these operations being effected under the full air pressure. After grouting, this full pressure was maintained for a further period of twenty-four hours, and was then reduced to zero at a regular rate during the next twelve hours. The air lock and air shaft were then removed, the concrete filling in the cylinder above the working chamber was placed in free air, the cast iron pier was erected and filled, and the temporary steel cofferdam strakes were removed.

At the City end, at the site of columns Nos. 1 to 4 inclusive, a series of test holes showed that the substratum consisted of fine running sand, subject to the tidal flow of the river. All the site of this land had, in the past, been reclaimed from the river, and it was decided that these columns should be carried on groups of reinforced concrete piles. Pre-cast reinforced concrete piles, 14in. by 14in., were therefore driven to depths varying from 18ft. to 56ft. below ground level. The number of piles under each column varies between five and eight and all were driven to a set of about ten blows per inch under ground being 4 tons per square foot. These foundations, as regards columns Nos. 18 to 22 inclusive, were excavated in the open, and no difficulty was found in securing a satisfactory bottom on a good stratum of gravel. At columns Nos. 17, however, close to the river bank, tidal water was encountered, and it was decided to employ 8ft. diameter cast iron rings as shaft lining, to be sunk under compressed air with the aid of a steel skin, external to the lowest ring, and cutting edge. This method was successfully adopted.

The five main river spans, each of 130ft., are formed of girders of the "N" type at 36ft. centres, which, unlike the main girders of the old bridge, are discontinuous. The upper and lower chords of these girders are connected by plate cross girders carrying longitudinal rolled steel joist stringers parallel to the main girders. The upper deck cross girders are carried outwards over the river beyond the main girders as cantilevers for a distance of some 12ft. in order to support the footways. The main girders rest on forged mild steel rocker bearings. Two expansion joints are provided in the five main river spans, and

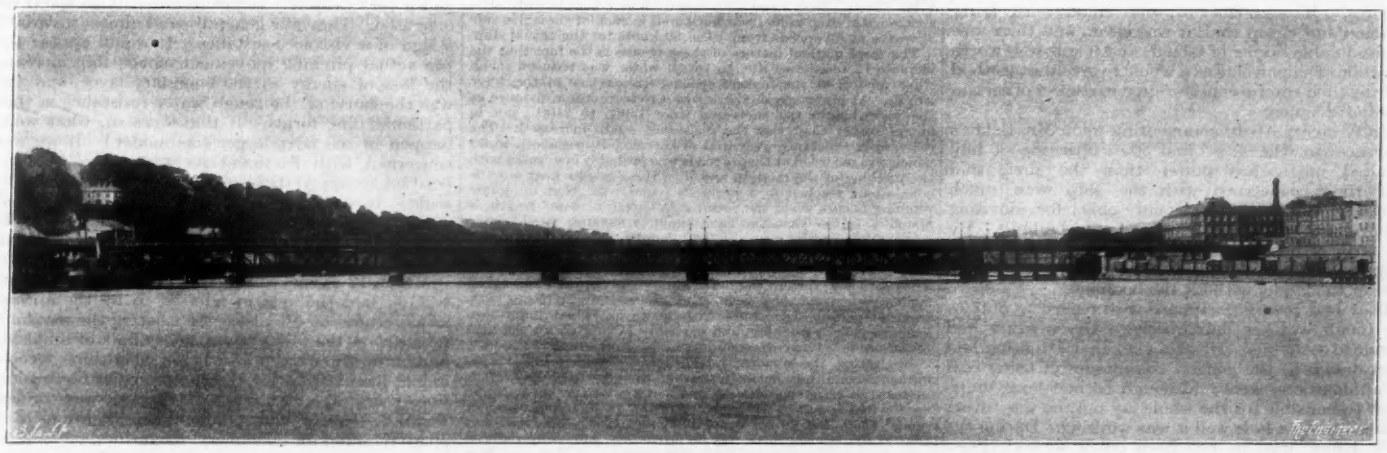


FIG. 3—GENERAL VIEW OF CRAIGAVON BRIDGE FROM DOWN STREAM—SEPTEMBER, 1934

These were driven by 65 h.p. motors, the current for these motors and for use on the works generally being obtained from the Londonderry Corporation Electricity Department's adjacent sub-station through a transformer close to the compressor house, and each compressor unit had its own oil-immersed switch and control panel. Cooling of the compressors was effected by water jackets, and a pump on each unit, the water circulating to three tanks outside the building. Three 5ft. diameter and 8ft. high air receivers were placed adjacent to the compressor house, from which two 4in. diameter and one 2in. diameter air mains were taken. The receivers were so inter-coupled that any one of the compressors would feed either the 4in. diameter low-pressure mains or the 2in. diameter high-pressure main. The pipe lines were supported over the railway and alongside the site of the founadtions for the new bridge, branches being placed at frequent intervals. Air pressure at 100 lb. per square inch was supplied through the 2in. diameter main for riveting, and at pressures varying between 10 lb. and 32 lb. per square inch for sinking the cylinders. After the air lock had been placed and coupled up, air was put on to balance the hydrostatic head, and excavation and sinking began. During this period concrete and further permanent cylinder strakes were added. On completion of the permanent steel cylinder and its concrete, temporary steel cofferdam strakes were added, these strakes being bolted together and to the top of the permanent cylinder. Further sinking weight was obtained by pumping water inside this cofferdam. No serious difficulties were encountered during the sinking periods, the position of the cutting edge being checked at the end of every working shift, and also after each time that the cylinder was "blown down."

Adequate foundations were obtained at reasonable depths on a stratum of good firm sand and ballast, mixed, in some cases, with large stones and boulders. The most awkward problem was to obtain a level bed for pitching those cylinders which were positioned close to the old bridge cylinders. These latter had been surrounded by coarse rubble pitching, and scour of the river had made a considerable sloping bank, amounting, in the chambers of certain of the new cylinders, to a slope of some 8ft. or 9ft. It was not possible to level off this slope completely by underwater grabbing. Consequently, the new cylinders were used as diving bells, the cylinder having, in one case, to be pitched about five times before being got into a reasonably correct position.

During the whole sinking period the air pressure was controlled from the main compressor station, and a medical air re-compression lock was kept in circuit with the air supply for the treatment of cases of air sickness. This lock was, however, fortunately very rarely used.

The depth of founding of the river piers varied from about 32ft. to about 68ft. below H.W.O.S.T. a 50-cwt. monkey falling 3ft. 6in. The piles were cast on the site. The reinforcement consists of four 1¼in. diameter longitudinal bars with ⅛in. diameter wire wound round at 4in. pitch, this pitch being narrowed down to 1in., 2in., and 3in. for the first, second, and third foot from the head and shoe respectively. A 56-lb. cast iron shoe with wrought iron straps was used, and the corners of the piles were chamfered 1½in. The concrete in these piles consisted of 3½ parts of ¾in. to ¼in. granite chippings to 1½ parts of sand and 1 part of cement. The pile caps, of a shape to suit the grouping of the piles, were 3ft. 6in. deep and were reinforced at top and bottom by ⅞in. diameter reinforcing bars. The driven piles were cut off 2ft. above the underside of the pile cap and the concrete was broken away, exposing the pile reinforcement, which was incorporated in the pile cap.

Between columns Nos. 4 North and 4 South a reinforced concrete wall 3ft. 6in. deep was constructed, resting on four piles, forming a girder carrying the lower deck stringers of span No. 5, and also a retaining wall to the river bank at this point.

The columns of approach spans Nos. 17 to 22 inclusive are carried on mass concrete foundations, each about 7ft. square, the allowable stress on the at these the rocker bearings are carried on forged mild steel rollers mounted in turn on rolled steel joist grillages on the concrete filling of the piers of the bridge. At piers other than those at the expansion joints, the rocker bearings under the end posts of the main girders are placed directly on these grillages.

The steel columns of the river and land approach spans (Spans Nos. 1 to 8 inclusive and 14 to 22 inclusive) carry a similar arrangement of upper deck cross girders and longitudinal stringers, while those of the river approach spans only (spans Nos. 5 to 8 inclusive and 14 to 16 inclusive) also carry lower deck cross girders and longitudinal stringers. At columns Nos. 4 and 17 expansion joints are provided in the upper deck, and the longitudinal stringers on one side of the cross girder rest on bronze plates seated on brackets on the web of the cross girder.

The order of construction for the river foundations was arranged to facilitate the erection of the steelwork by easy access from the river bank. The steelwork was shipped directly to a wharf on the river bank at the Waterside, immediately adjacent to the site of the bridge and constructed specially for the purpose, and was there unloaded, sorted, and stacked.

(To be continued.)

Institution of Naval Architects.

No. III.

(Continued from page 416, April 19th.)

AT the morning session on Thursday, April 11th, with Sir Charles Sanders in the chair, Sir Westcott Abell presented a paper on "Channel Train Ferry Steamers for the Southern Railway" excerpts from which are given on another page.

DISCUSSION.

Mr. G. S. Baker, of the William Froude Laboratory, National Physical Laboratory, said that the proportions of the vessels were quite out of the usual, and the very definite restrictions with regard to draught had made propulsive conditions somewhat difficult. That was a case in which the tank could legitimately claim some share in the successful results obtained. There was very little experimental or ship data on which to proceed. Altogether, five model hulls were tested in the tank, each showing a steady improvement in power, the last one requiring 16 per cent. less power than the first, with a reasonably flat © curve.

The steamer was also a little unusual compared with other broad and shallow vessels in having solid bossings, particularly as with the fine form these were of fairly large dimensions. The form and line of these bossings were determined by the normal tank method. The model tests had shown that their resistance was comparatively low, and the good propulsive coefficient and low thrust deduction factor showed that at least there was no cross flow. No vibration of any sort was experienced on the ship trials, both loaded and light, and that also helped to support the accuracy in the placing of the bossings by that method.

The estimated shaft horse-power obtained on the ship trial (estimated from the engines and not taken by torsion meter) was 4570. The power given in the tank report for the same speed, corrected to the same displacement, was 4360 at the propellers, or, allowing 5 per cent. for shaft losses, 4590 at the engines, *i.e.*, within 1 per cent. The revolutions from the tank were some 4 per cent. high, when corrected for displacement. That was a rather unusual discrepancy, as, in general, tank estimated revolutions were 1 or 2 per cent. low. In the later trial on the Hampton Ferry the error between ship and model estimate for revolutions was of the latter kind. Except for the

discrepancy in the revolutions, the tank data were completely borne out by the ship trials.

Engineer Rear-Admiral W. M. Whayman said it was interesting to marine engineers to know that there was an increasing number of machinery installations afloat of a similar type to that adopted in the train ferries. He hoped within the next few months to attend the trials of another cross-Channel steamer, in which the water-tube boiler and the mechanical stoker had been adopted. In that case there were four boilers and four mechanical stokers, and the builders were arranging for the automatic feeding of the coal in a manner similar to that described in the paper. Commenting on the point that the results of the trials at sea appeared to be somewhat better than the figures given for trials on shore, he said that the steam generating results given for the trials at sea were based on the gross calorific value of the fuel, whereas for the trials on shore the net or lower calorific value was given.

Sir Harold Yarrow doubted very much whether shipowners as a whole appreciated fully the advantages of this system of water-tube boilers and mechanical stokers on certain of their ships. It was not new, but it was very unusual and had very many attractive features. It was efficient, one could burn fairly common and cheap coal, it was clean, and there was a considerable saving of labour, and it was well worth the while of shipowners as a whole to give that method of firing their careful consideration in respect of certain types of steamers.

Sir Westcott Abell, commenting upon Mr. Baker's reference to the fact that the fifth model hull required much less power than the first, said that those concerned with the ship were much indebted to Mr. Baker, not only for devising a shape, but one which could actually be built. By the form of bossing adopted, they had arrived at a shape which had added only 4 per cent. to the resistance of the model without the bossings.

They had been unfortunate with regard to obtaining rough weather data, because the weather had remained very fine. He was glad that attention had been drawn to the general advantages of using coal on automatic stokers; although he had been somewhat responsible for the whole lay-out, he was rather amazed to note how well it was working. During the eight hours' trial he had been below several times. The two men in the boiler-room and the two men in the engine-room were sitting down, and the machinery did its work apparently without attention from anybody. Further, no smoke could be seen throughout the whole time. The system was one which could be followed, not only in that type of ship, but in many others, the principal gain being that one could cut out weight. There was no doubt in his mind that in that case, at any rate, the closed stokehold system was of material advantage, and he could discover no disadvantages with the lay-out.

The next paper was entitled "Resistance Experiments in Smooth and Rough Water Made with Models of High-speed Ships," and was by J. L. Kent and R. S. Cutland.

RESISTANCE EXPERIMENTS WITH MODELS OF HIGH-SPEED SHIPS.

This paper gives the data obtained from resistance experiments in smooth and in rough water upon three ship-model hulls of the cross-channel type. All three models had the same principal dimensions and displacements, and the same curve of cross-sectional areas, but they differed in the longitudinal positions of the maximum beams at the various water planes, which were arranged so that one model, 1255, was of normal form, the second model, 1258, had V-shaped sections forward and U-shaped sections aft, and the third model, 1250, *vice versâ*.

The smooth water tests indicated that the normal form was the best over a wide speed range, with the models trimmed to a level keel and also when trimmed by the stern.

In rough water the average resistances obtained again indicated that the normal form experienced the least increase in resistance due to waves at practically all speeds.

Resistance tests were made with each of the models trimmed to a level keel over a range of speeds corresponding to 12–30 knots for the 400ft. ship. For the greater portion of the speed range the parent form (No. 1255) gave the best result, and the full bow water line model (No. 1250) was the worst at low speeds, while at the highest speeds the fine bow water line model (No. 1258) was the worst.

To throw further light on the effect of the shape of the water plane upon resistance, each of the three models was ballasted to correspond to a trim of 6ft. by the bow and also 6ft. by the stern, and the resistance experiments repeated. The parent form (No. 1255) gained nothing by trimming the model by either the bow or stern, the resistance being increased in each of these conditions. The model with the full bow load water line (No. 1250) showed a considerable reduction in resistance at low speeds when trimmed by the stern, but this reduction was lost at high speeds, and trimming by the bow gave increased resistance at all speeds. The model with the fine bow water line (No. 1258) showed no gain in trimming the vessel, except at the highest speeds, when the trim by the stern reduced the resistance.

Comparing the three forms at low speeds (*i.e.*, less than (P) = 0·9) there was no material difference in the resistances of models 1255 and 1258 trimmed to a level keel, whilst the fuller bow angle (model 1250) gave a worse result. All the vessels trimmed by the bow showed increased resistance, and when trimmed by the stern there was a large reduction in resistance for model 1250, a smaller reduction for model 1255, and practically no change in resistance for model 1258. This supports the view that there was no practical gain at these speeds by reducing the bow angle below that of the parent form (model 1255).

At higher speeds (from (P) = 0·9 to (P) = 1·25) the parent form gave the best results in level trim, and no advantage over this form was obtained by trimming either of the models by the bow or stern.

At the highest speeds (*i.e.*, greater than (P) = 1·25) models 1255 and 1250 had the same resistance in level trim conditions, and model 1258 considerably greater. Trim by the bow gave results practically identical with level trim conditions for models 1255 and 1258, and an increased resistance for model 1250. Trim by the stern gave a better result for model 1258, while for model 1250 the resistance was slightly increased, and for model 1255 considerably increased.

On the whole, there is no advantage to be gained by departing from the parent form (model 1255) either by fining or filling out the bow angle.

Trim by the bow gave a worse result, except at the highest speeds, when the resistance was approximately the same as at level trim conditions. Trim by the stern was worse for the normal hull form, advantageous for the full bow line ship at low speeds and for the fine bow line ship at high speeds.

Resistance Due to Bulbous Form of Bow Lines.—Model 1258 had a bulbous fore-end, and in order to find out to what extent this bulbous form had affected the resistance of the model hull, the swelling was removed and the model re-tested at the same draught in the level trim condition.

The results showed very little difference in the resistance at low and intermediate speeds, but at very high speeds the presence of the bulbous end definitely reduced the resistance. This may be due to the quick growth of stern trim at high speeds upon the bulbous lines at the bow, and the experiments with all three models support this view.

Rough-water Experiments.—Resistance experiments were made with each model trimmed to a level keel and towed "head on" through regular trains of waves created by a wave-maker situated at one end of the tank. In these rough-water experiments care was taken to tow each model hull from its centre of gravity, so the models were ballasted to give the same transverse metacentric height in each case, and all three had approximately the same longitudinal period. Five sets of waves were used in these tests of lengths corresponding to 140ft., 175ft., 240ft., 360ft., and 530ft., and all of 6ft. in height. The resistance of each model was measured in each of these five sets of waves at all speeds from 16 to 30 knots for the actual ship.

The most marked feature of these results is the fact that the increase in resistance due to rough water was reduced in all three models at the highest speeds, irrespective of the wave length. At lower speeds there was a reduction in resistance as the wave length was increased from 140ft. to 240ft., but in longer waves than this the resistance again increased. The increase in resistance over that of the models in smooth water which was recorded at these speeds was probably connected with the pitching of the models, and if so these results bear out the conclusions reached in a previous paper, viz., that minimum pitching occurs when the ratio, ship length to wave length, is about 1·74, so that the increase in resistance would be a minimum in regular waves of 230ft. length. The ship's period of encounter when towed through waves of 370ft. length would vary between 5½ seconds and 4 seconds, according to the speed. That is to say, that at the lower speeds the models approached synchronous conditions between their natural pitching periods and their periods of encounter with the waves. This synchronism leads to violent pitching, and probably accounted for the high resistance in waves corresponding to 370ft. in length.

Neglecting the abnormal resistances obtained under synchronous conditions between ship and wave periods, the average increase in resistance due to rough water at the lower model speeds was about 12 per cent. for model 1255, 16 per cent. for model 1250, and 20 per cent. for model 1258. This indicates that at low speeds there was no advantage gained by reduced resistance in rough water from the pronounced V-shaped bow sections of model 1250 or from the bulbous form of bow sections of model 1258.

At high speeds (*i.e.*, (P) > 1·1) the increase in resistance due to rough water decreased with increase in speed, until there was practically no increased resistance over that in smooth water, at a speed corresponding to 29 knots. Yet at this speed all the models pitched through angles as large as those at the lower speeds! This decrease in the additional resistance due to rough water commences at about 23 knots, and during the smooth water experiments it was observed that at this speed the bow and stern waves created by the model began to break.

The following theory is advanced as explaining the above facts. It is suggested that when the bow or stern wave of a vessel breaks there is an increased resistance to the ship's motion because the hydrodynamic flow past the ship has become discontinuous and the surface water of the succeeding waves must be drawn from sub-surface layers. It follows that at low speeds, when the waves created by the ship do not break in smooth water, if the vessel encounters ocean waves of sufficient height, then the bow and stern waves will break as each succeeding crest of the ocean waves passes through them, and an increased resistance will result.

If the speed is high and the ship waves are completely broken in smooth water, because their height/length exceeds, say, one-tenth, then the hydrodynamic flow is already discontinuous in smooth water, and the superposition of ocean waves will not appreciably increase this discontinuity and no increased resistance will be felt when the ship moves through such waves.

Discussion.

Mr. F. McAlister said it was curious that until the Froude Tank started work in 1910 very little information had been published on full forms, the main work covered by the various authorities having been concerned more with cruiser and other forms of low coefficients. Since 1910, however, there had been a great deal of research on full forms; so much so that there was a slight danger of mental indigestion. It was therefore a pleasure that the authors had investigated the possibilities of a form of 0·567 block coefficient.

The authors had not emphasised the fact that the same types of lines which produced the best smooth water result also produced the best performance in rough water. It was gratifying to bear in mind that the smooth water test for this type of vessel was a reliable indicator of the excellence of its service performance. The order of superiority of the three types, *i.e.*, U-shaped bow sections at the low speeds, medium bow sections at medium speeds, and V-shaped bow sections at high speeds, was also generally in line with Channel boat design.

The most interesting feature of the paper was that distinguished in the literature of the Froude Tank by the mark of exclamation. He referred to the interesting result at the higher speeds where there was practically no increase in resistance over smooth water. The authors had undoubtedly stumbled upon a somewhat similar phenomenon to that published by Barillon, who had shown in 1926 that in a suitable field of artificial waves the wave-making resistance could be reduced to zero, and, further, that a model placed in a suitable field maintained by three similar models could have its total resistance completely annulled. In view of Barillon's work, the authors' result might be accepted as undoubted. Mr. McAlister gave a rough explanation by reference to interference, which could modify resistance. In certain classes of ships there were variations of different bow forms, which gave different interference and the best type of bow for a ship depended upon the speed at which the ship was run.

He did not wish to pass any dogmatic opinion upon the authors' theory, except to question their use of the word "ship." They appeared to infer that the reduced resistance in the case of the model could definitely be established in the ship, and whilst he could not prove that that statement was wrong, he asked if the authors could prove that it was correct. The authors' theory was founded on the breaking of the bow and stern waves in the Tank, and he had always been surprised at the smooth nature of the waves created by model hulls, whereas most ships, even at low speeds, showed the foaming or creaming of the bow breaker. He asked if that was correct in general, and, if so, whether the authors suggested that it was a viscosity effect or a fresh *versus* salt water effect.

Dr. E. V. Telfer suggested that the most significant factor about the results—and he disagreed with Mr. McAlister in that respect—was that the difference between the smooth water and rough water results was more of the nature of a viscous addition, which had a very definitely reducing intensity as speed was increased. That was generally and almost invariably a sign of a viscous resistance. It would appear that the actual pitching movement of the ship increased the loss of energy in the boundary layer, and that was the cause of the rough water resistance in those particular fine forms. If that were so, what would happen in the next larger size model? If we were concerned with frictional resistance, we were not entitled to apply those model differences to the full scale. It would be valuable if the authors could carry out similar experiments on a larger model. After all, we had to take a terrific amount on trust between the model and the ship.

Mr. M. P. Payne, considering first the smooth water results, said the system referred to by the authors, as advocated by Maudslay for locating the maximum breadth on the lower water lines abaft of amidships and of the lower water lines before amidships, received ample justification for the speeds realisable seventy-five years ago, when the proposal was brought forward. In warships, practical considerations of the space required for machinery, magazines, oil fuel, &c., played a major part in determining the position of the maximum breadth at various levels, but the experience was broadly that the requirements of low resistance had not been unduly prejudiced by the other requirements of the design. He suggested that conclusions from the present results should not be pressed too far, since in the first place the two departures from the parent form were of rather an extreme character, and it was possible that an intermediate model with a less extreme variation in the locus of maximum beam than in model 1258 might not show a proportional penalty, if penalty at all, at the high speeds. Again, generally there was a complete reversal of the influence of form on the resistance in that portion of the speed range comprising the steep ascent to the main hump of the © curve, and the experience was that one had to be particularly careful in drawing conclusions for any speed within that small range. Lastly, one could safely conclude that the parent form was a fairly good one, and the effect of any departures must be considered with that in mind.

Subject to those considerations, it would appear from the present experiments that if the maximum breadth of the surface W L could not be at amidships, it was better for it to be forward than aft at high speeds, and for the maximum breadth of the lower levels to be aft of the maximum breadth on the L W L. That was an interesting and useful result, particularly as it was confirmed by the rough-water experiments. It also appeared that the difference in resistance that might be attributed to the relatively small departures of the maximum beam from amidships, which might be admissible in practice, was of a small order. The results showed that the forms which were better at the bottom of the ascent of the main hump were worse at the top, and *vice versâ*—an example of the perverse tendency already mentioned.

The authors' remarks on the effect of the bulbous bow were another example of the perversity already mentioned, whereby an improvement at high speed had to be weighed against the disadvantage at low speed or the reverse. Here, again, caution was urged in so far as the results applied strictly to the particular forms under consideration. Further, the comparison was at the same draught and not at the same displacement, and was appropriate to a model of abnormal shape of level lines. There was a fair range of conditions under which a bulbous bow might be of advantage at the high speeds here in question, but very few circumstances in which it was an advantage at all speeds throughout the speed range. Mr. W. Froude's early experiments at Torquay included trials of models with so-called "swan" bows, which were generally similar in type to bulbous bows. He had found that the resistance was improved at the higher speeds, corresponding to about (P) = 1·2, but was prejudiced at lower speeds. Many warships of high as well as moderate speeds, had rams or other variants of the bulbous bow, and, broadly speaking, the original results of Froude were confirmed in tendency,

but with the qualification that at high cruiser and destroyer speeds the improvement was often small and frequently the results were not so good as with an equivalent non-bulbous form. Considering the rough-water results, the reduction of the resistance "augment" due to rough water at high speeds was of great interest, especially as it occurred with all three forms. The pitching period was made approximately equal in the three cases. That was undoubtedly a desirable condition from the scientific point of view, but it might not be achieved in a practical design. An important conclusion derived from the experiments at Haslar, recorded in Mr. R. E. Froude's paper in 1905 on "Hollow *versus* Straight Lines," should be borne in mind. It was that the question of performance when steaming against a head sea was less one of particular underwater shape than one of longitudinal stability *versus* longitudinal inertia. If the shape were influential, it was mainly by indirect effect upon those conditions.

Mr. H. G. Williams considered that from the point of view of hydro-dynamical theory, the authors' explanations were highly problematical and speculative. It was to be noted that they had stated their results in (P) form, from which, as the speeds were given, one could deduce the prismatic coefficient of the vessel, and he imagined that that was of the order of 0·75 for that type of ship. He recalled that last year a great meeting of tank superintendents had agreed on a system of nomenclature or a system of units in which future experimental results were to be put forward. He would like to know when the Teddington Tank officials intended to adopt the internationally agreed system.

Mr. W. W. Marriner, referring to his experience of running torpedo-boat destroyers in all kinds of weather, said that he and his colleagues felt that, whatever the weather, it did not affect the result seriously; indeed, they said that the worse the day, the better the result. They had run boats off Dover when the Channel service had been interrupted, and in the big swell of the Atlantic off Lisbon when the fishing boats were all kept in the harbour. On a trial trip they had to run both with and against the wind, and it was remarkable that the waves had not very much effect on their results.

Mr. Kent, replying to some of the points raised in the discussion, agreed with Mr. McAlister that in respect of the majority of ships, the smooth water resistance test would be sufficient to indicate what would happen in rough water; but he pointed out that there were special forms in respect of which rough water tests should be carried out. The difference between the bow breakers of a model and a ship might be due, as Mr. McAlister had pointed out, to viscosity, or perhaps to surface tension to a certain extent, and he believed it was also due to wind. It was amazing how the bow breaker did vary from second to second on a ship which presumably was running steadily; but one did not see that on the model. So that there were differences in the bow breakers, and possibly in other respects, between the model and the ship, which differences needed investigation. With regard to Dr. Telfer's suggestion that they should run models of different scale in rough water, Mr. Kent pointed out that the collection of the information contained in that short paper had occupied 3½ years. If they had time to deal with models of different scale, they would certainly do so.

He agreed with Mr. Payne that the results should not be pressed too far, because the departures were rather extreme. It was the intention to deal with these extreme cases and afterwards to deal with intermediate forms, but the work on the latter had not been done from lack of time. The parent form was pretty fair; but it was hoped to do better. He agreed with Mr. Williams that the theory advanced in the paper was highly speculative. The authors had put it forward for want of a better one, and he did not think anyone had yet produced a better one.

He welcomed Mr. Marriner's confirmation that in practice there was no increase of wave resistance at high speeds.

The next paper was on "A Simplified Form of Direct Flooding Calculations," and by Mr. J. L. Scott. It was presented, in the author's absence, by Sir Westcott Abell.

FLOODING CALCULATIONS.

Although the calculation of the amount of length of a ship which can be flooded at any particular position without sinking her is fundamentally simple, yet the application to an actual form is complicated, and the determination of the particular amount of length at a given point involves calculations which seem, and are, very laborious.

The object of the author has been to discover some way of direct calculation—that is, calculation from fundamental principles—which, while attaining a sufficient accuracy, would involve only a reasonable amount of labour.

Here, reference may be made to the paper by Sir Westcott Abell on "Direct Flooding Calculations," read before the North-East Coast Institution of Engineers and Shipbuilders on March 21st, 1930.

In this paper, the total displacement and the position of the longitudinal centre of buoyancy are calculated for a series of tangents to the margin line, by derivation from the corresponding even-keel water-line displacements and longitudinal centres of buoyancy. For this derivation, correction is made by a factor allowing for the variation of the above-water form by means of coefficients.

With this information, a key diagram is plotted, which gives the amount of lost buoyancy permissible, together with its longitudinal centroid for any particular tangent (the draughts of which are calculable) to the margin line.

Using the Bonjean curves to give the curve of areas of cross sections for a particular water line, the length of the curve which will give the required lost buoyancy with its proper centroid is obtained by a process of trial and error.

The paper is a method of direct calculation from first principles, based on the usual hydrostatic curves up to the load water line, supplemented by the same properties for two other water lines above the load water line.

The paper seems to suggest that it may be possible to throw the calculations into a simple direct form by the use of Bonjean curves, and by the use of the Integraph, which has been found very helpful in such cases as these, where, fundamentally, only displacements and longitudinal centroids are involved.

This method takes full account of both the under-water and above-water forms, including stern appendages, and minimises numerical calculations, since the process is largely a mechanical one, is practically self-checking, and is well adapted for rapid and independent verification.

While there are undoubtedly many methods of applying the Integraph to these calculations, it has been considered that, subject always to the attainment of accuracy with economy of time, it is preferable from every point of view to adopt a simple, direct, and self-explanatory method, whereby each part of the procedure is clearly set out in a manner which may readily be visualised at any stage of the calculation.

The method employed is a "direct" or "first principle" one, as the calculations are made directly from the vessel's form, each individual ship being treated on its merits.

Bonjean curves extending to the margin line are used for obtaining the total displacement and longitudinal centre of buoyancy for successive water lines tangential to that line, this being the usual procedure where a complete curve of floodable lengths is required. With an Integraph the foregoing properties can be accurately and quickly obtained, and the remaining portion of the calculation dealt with by any of several methods.

DISCUSSION.

Mr. Lloyd Woollard said that Mr. Scott appeared to have devised a method which enabled the floodable lengths of any ship to be calculated with a minimum of time and labour, and great ingenuity had been exercised.

Dr. E. V. Telfer pointed out that although, throughout the paper, the author, in common with many other naval architects, had referred to the curves as Bonjean curves, actually those curves were some 200 years older than Bonjean himself. Bonjean, realising the difficulty of the use of the curves for interpolating the trim condition, had constructed a solidity scale, a simpler method of interpolating the terms of area than was the method generally used by Mr. Scott and others.

Dr. Telfer expressed surprise that Mr. Scott did not forego his present love for the Integraph and realise that most of the integrals for the trapezium form could be written down straight away, being just the combination of two triangles.

Professor P. A. Hillhouse suggested means by which Mr. Scott's simplified method of direct flooding calculations could be still further simplified.

Mr. J. G. Johnstone suggested that if, instead of taking the Bonjean curves, the author had merely taken his selected water line and worked by differences from the load line, he could have calculated them very easily, and would have been able to integrate the curves along the length in one step, and his results would have been much more accurate.

Sir Westcott Abell referred to the long search for a method of determining the floodable length at any portion of the ship which should be both convenient and accurate. The official method of calculation was admitted to be approximate, and was liable to certain inaccuracy for reasons not to be foreseen. For that reason it had not yet been possible to adopt a standard of calculation that was internationally acceptable. Mr. Scott had set out to devise a scheme which should be entirely free from personal error, so far as that was humanly possible, which should automatically check itself and should be capable of modification at any stage of the process of calculation. He believed Mr. Scott had achieved his object, first, by the use of the Integraph, and secondly, by setting out the successive stages, *en echelon*, so that the maximum information was obtainable with the minimum of calculation.

On Thursday afternoon, April 11th, Sir William Berry presided, and two papers were read and discussed. The first was "Steamships with Main Boilers on Deck," by Mr. K. G. Meldahl, of Norway.

STEAMSHIPS WITH MAIN BOILERS ON DECK.

From time to time various methods have been employed to increase the cubic capacity of cargo steamers because so many different kinds of cargo need space rather than D.W. carrying power. But hardly any alteration in the disposition of the steam plant has been tried in order to gain cargo space.

Considering the steam machinery for a ship, it is seen at once that the engine or turbine demands its place on the bottom of the ship, except where electric transmission to the propeller shaft is used.

If, therefore, in a given ship, more cargo capacity is desired, and this is to be attained by elevating part of the machinery, it must be the boilers which have to be lifted up to effect a perceptible gain of cargo capacity.

By doing this we find that the stability of the ship in loaded condition as a rule will be unaltered or somewhat greater, because the cargo filling the space where the boilers were weighs more than the boilers.

In ballast condition, however, a marked alteration takes place when the boilers and bunkers are lifted up. With boilers on tank top as hitherto, the stability is too great, causing violent rolling of the ship, with various undesirable consequences, but with elevated boilers the rolling motion becomes easier, for two reasons, viz.:—

(1) The excessive metacentric height which most cargo ships have in ballast conditions is considerably reduced; and

(2) The moment of gyration of the ballasted ship is augmented, because the masses of the bunkers, boilers, &c., are placed further away from the axis of rolling.

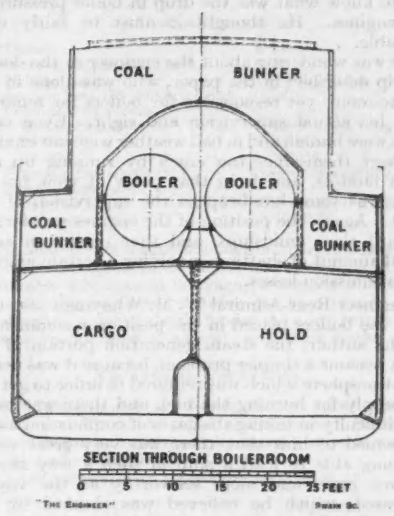
The axis of roll is also lifted somewhat higher above the ballast weights, whereby the moment of gyration is further increased; actual experience shows that, for instance, the period of roll is augmented, in one case, from about 8 seconds for a complete roll to about 11 seconds.

The beam of the ship may now be increased somewhat and still no unpleasant rolling sets in; and thereby the ship gets a marked increase of carrying power at shallower draughts, which is of considerable value when the ship has to go through lock gates, over river bars, &c.

The stokers get incomparably better working conditions, particularly in the Tropics, where it is well known that the temperature in ordinary stokeholds may be 15 deg. to 20 deg. Cent. above that of the outer air, whereas an elevated stokehold shows only about 5 deg. Cent. more than outside. The admission of full daylight, opportunity for spray bath, and wardrobe for changing clothes further improve the conditions.

At the same time economy and comfort is improved by abolishing the ash hoist with its unpleasant work, the ashes being passed overboard through a shoot. The stokers may, in case of emergency, carry on their work to keep steam for pumps, steering, winches, dynamos, &c., till the very last without risk of drowning.

The whole accommodation for the officers is improved by being collected into one house, which is compact and easy to



light and ventilate both transversely and longitudinally, the engineers in particular getting very much better quarters, all of which are easy to watch in port. There is no heat from boiler uptakes, &c., neither do the latter cause undue heat in the spare bunker with the accompanying risk of gases, fires, &c. No damage to cargo by heat, either in hold or in spare bunker, need be feared.

The stowage of cargo is improved, because the rectangular best part of the hold is made more available than hitherto.

The dry tank is abolished, as is also the extra thickness of floors and tank top below boilers, and there will be no expensive renewal of tank top below the boilers.

The increased ballast quantity gives better immersion for the propeller, and hence better ballast speed, which is further increased because the ship actually rolls less.

The gain in cubic capacity for a given D.W. is found to be about 6–10 per cent., the latter figure referring to the fruit carrier type. This gain of capacity must be judged in comparison with the percentage of capacity which brings the earnings. Hence in many cases the dividends may be multiplied by this increase of capacity. No increase of steel and other weights is caused, but, as before stated, the ash hoist is saved, and the cost of construction is, if altered at all, reduced. The type of ship has for this reason been called the "super-cubic" type, in order to indicate that, whatever any given type has attained as regards capacity, the lifting of the boilers will give rise to a gain of space, free of charge.

If, on the contrary, only a definite cubic capacity is desired, the principal dimensions may be reduced, as well as the engine and boiler dimensions, giving rise to a reduction in the cost of construction of about 3–5 per cent., as well as a similar saving of fuel and bunker capacity.

In order to carry the boilers it has been found best to support them on longitudinal girders and bulkheads resting in their turn on bulkheads below, and suspended from bulkheads above the boiler deck. By this means the space below the boiler-room becomes quite unobstructed.

The rolling motion causes no serious wash inside the boilers, as is proved by model experiments as well as by the fact that the superheat temperature of the steam does not fall during heavy rolling motion, which it would do if the superheater had to deal with water carried along by the steam. Boiler water level indicators are installed below, in the engine-room. Convenient stairs between engine and boiler-room are arranged.

The permanent coal bunkers are conveniently placed on top of, and alongside of, the boilers, and the spare bunkers around the engine casing with direct access to the stokeroom, thus giving the easiest trimming.

The register tonnage per cubic foot cargo capacity is only slightly smaller than before, as might be expected, the advantage amounting to about 1–2 per cent. Usually, when the engine space below the tonnage deck does not amount to 13 per cent. of the gross tonnage, part of the engine and boiler trunks above this deck is registered and added so that the 32 per cent. reduction is secured. A pure D.W. carrier with elevated boilers will therefore be at some disadvantage in this respect.

The type has proved perfectly seaworthy in the severest weather, and the boilers and engines have worked normally.

DISCUSSION.

Captain W. J. Willett Bruce said it was quite novel to think of boilers being on deck, and in that connection he recalled a quotation from the Presidential Address to the Institute of Marine Engineers this session, which referred to a case in which a sailing vessel built at Blackwall had her two auxiliary boilers placed on the main hatch, but the master was so infuriated at the dirt and filth that he threw the boilers overboard! It was to be hoped, he added, that none of the skippers in charge of the boats designed by the author would act in that way, because undoubtedly the method described enabled the skipper to do better for his owner. Although it was claimed that rolling was easier, he was not quite clear about that, and would like to know whether the angle of heel had been reduced, and if the intermittent

time between the periodicity of the rolls had been increased, and in that way the number of rolls in a given time had been reduced to a minimum. That class of steamer which was 240ft. long by 40ft. beam seemed to him likely to be subject to bad pitching in very strong head sea and a head wind. The author, however, had not alluded to pitching, and he would like to hear more about it, because he felt that with the boilers in the position indicated, and with the steam pipes at such an elevation, and with such a serious drop to the machinery, however careful the arrangement, they might be the cause of some trouble. It might be, of course, that baffles had been arranged to prevent water being taken over, but in bad weather conditions, with the ship pitching badly, a serious amount of water might be carried over, which with the velocity of the steam, plus the weight of the water, would possibly lead to very serious accidents to the machinery and to human life. He also would like to know what was the drop in boiler pressure to the engines. He thought it must be fairly considerable.

He was wondering about the engineer in the design of ship described in the paper, who was alone in the engine-room yet responsible for boilers far removed from his actual supervision and sight. Even engineers were human and in bad weather were not anxious to exert themselves too much by running up and down ladders, and from that point of view he felt there was some handicap to the supervision of the plant. Again, the position of the engines was farther forward than amidships, and that meant an additional amount of shafting, involving a certain amount of transmission losses.

Engineer Rear-Admiral W. M. Whayman said that with the boilers placed in the position recommended by the author, the steam generation portion of the plant became a simpler problem, because it was nearer the atmosphere which was required in order to get the air supply for burning the fuel, and there was much less difficulty in taking the gases of combustion away. It seemed to him that there was very great virtue in being able to load a ship in such a way that it became more and more seaworthy as the voyage increased, which he believed was claimed by the author for his new arrangement of the boilers.

Captain F. W. Cutliffe expressed his agreement with everything the author had put forward from the experience he had had as a shipmaster and harbour master. It had been a matter of surprise to him that, having increased the beam of ships, no effort had hitherto been made to rearrange the engines and boilers. Forty years ago he crossed the Atlantic in a 4000-ton ship, and the practice then was to put 200 or 300 tons of sand on the decks to eliminate the rolling, and that resulted in a much easier ship. Of course, ships forty years ago did not have so much beam as to-day, but if the use of sand in that way affected for the better the seaworthiness of the ship, then it could well be accepted that the placing of the boilers in the position advocated by the author would, in conjunction with greater beam, add to the stability of vessels to-day.

Mr. H. E. J. Camps asked whether it had been found necessary to increase the height of the funnel substantially in order to get the necessary draught for combustion in the furnaces. Another point was that, as boilers and engines were arranged at the present moment, it was very difficult to get a lead from the boilers to the engines, especially when there were three boilers, without running the risk of having water hammer in the pipes under certain conditions. In the design described by the author it occurred to him that with the arrangement of the steam pipes almost vertically from the boilers to the engines, the possibility of water hammer, owing to the horizontal leads, could be very much reduced. It seemed to him that the author's proposal was a definite step in the right direction in case of accidents, in that it reduced the possibility of submersion of the boilers when the lower part of the ship was under water and water had access.

Mr. Wilfred Ayre said he had had the pleasure of seeing the author's ship "Bencas" some months ago in London, and arising out of that one or two thoughts had occurred to him affecting the design. He did not know what the diameter of the two boilers was, but the propelling machinery in the "Bencas" was of a very highly efficient type, consisting of forced draught boilers, engines using superheated steam, and a type of engine that was reputed to be very economical, and he believed was. For that reason it was possible to get the boiler diameter down to very small proportions, and he would not be surprised if these particular boilers did not exceed 10ft. 6in. diameter. [The author: They are 9ft. 6in.]

Mr. Ayre, continuing, said the thought had occurred to him that if the endeavour was made to get two 14ft. boilers into this casing, and then leave room for a coal chute, on each side to save deck space, it would be necessary to increase fairly substantially the beam of the vessel, otherwise there would be trouble with the bunkering arrangements. Hence, it seemed to him that with the author's design it was essential to have very efficient propelling machinery with a view to keeping down boiler sizes.

The question of propelling machinery also brought into prominence the available amount of bunker space. In the author's design he was rather restricted in the bunker space which he could get above deck without encroaching too much on the extension of the bridge between decks, and if it was necessary to have less efficient machinery which would put up the size of it, increase the fuel consumption, and also increase the amount of bunker space required, there might be some difficulty in getting sufficient deck space to provide adequate bunker space to carry the ship on an average timber voyage, for example.

Speaking with regard to the endeavour to obtain what was called an easy trimmer, and to get the designation accepted by the Trimming Board in order to obtain the recognised reduction in trimming rates, Mr. Ayre pointed out that it is necessary to get a distance not exceeding 12ft. in the ends of the hatch. It was difficult to escape having to exceed 12ft. ends in timber-carrying vessels generally, and it did not seem to him that it would be an easy matter to escape it in this particular design.

Finally, Mr. Ayre said that in order to get adequate bunker space in this type of design, it would be necessary to go between decks, and this led one to suppose that there would be more trimming of bunkers between decks than in the orthodox type, where a larger volume of side bunkers in both engine and boiler-room space was available. Perhaps the author would be able satisfactorily to explain that point.

The author, in his reply, speaking on the question of the effect of roll, said that in the case of the French boat "Felix-Henri," he had received wireless reports daily from a voyage made in very bad weather in the Bay of Biscay. The vessel rolled up to 18 deg. each way, and there had been no priming whatever, owing to the fitting of baffle plates in a particular way. They had also fitted on that vessel plates such as were found on trawlers which took the splash, and, in addition, there were centrifugal purifiers, and last, but not least, superheater coils. The result was that there was no reduction of superheat and that was proof that there was no moisture in the steam leaving the boiler. On the other hand, in the sister vessel, which had boilers and engines of the same type, but one diameter larger, so that steaming should be easier, there was priming. In the case of that vessel, however, she rolled in 8 sec., whereas the "Felix-Henri" rolled in 11 sec.

With regard to the drop in the steam pipes, the pressure was 15 atmospheres, and the drop was from ½ to 1 atmosphere in the "Felix-Henri." That boat had crossed the Bay of Biscay thirty-two times, and had kept its service at times when some of the big liners had been obliged to heave to. Even during the first year when she was comparatively lightly loaded, so that she danced about a good deal, the rolling had not been reported to be more than 18 deg. either way. As to the engineer having to go to and from his quarters and the boiler-room, he had been provided with comfortable stairs. Personally, he had walked up those stairs whilst the ship was at sea, with his hands in his pockets, so that he did not think any complaint could really be lodged by the engineers in that respect, and, moreover, the engineers had their rooms now where ordinarily the saloon was. There were indicators for the water level placed in the engineer's quarters, so that the engineer could always see how the boiler gauges stood.

No mention had been made in the paper of the longer shafting necessary, but, as a matter of fact, it was contemplated shifting the machinery a bit further aft, which would have the effect of shortening the shafting, and providing a little more cubic capacity for cargo, at the same time saving in weight and cost.

On the question of the necessary draught, he admitted that in one case in which the coal was not first class, the funnel had not enough draught, and another 5ft. was added to it. It was possible that an extension of the funnels would be adopted in the future, although under normal conditions it was not necessary from the point of view of draught.

As to the diameter of the boilers, there would be no difficulty in having boilers of larger diameter if the owner preferred to stick to the old type and carry more coal. Personally, he preferred smaller and more economical boilers, because of the difficulty of having to carry more coal, and also possibly having to buy coal on a voyage at high prices. Moreover, the smaller boilers allowed of more space for cargo, and taking all considerations into account, he was convinced that although highly efficient machinery might be more expensive in the first case, the savings in coal consumption and increased cargo space more than outweighed this disadvantage. In Norway they were compelled to adopt the most economical machinery, because of the high price of coal which had to be imported there. He believed that economy would force itself to the front eventually, solely on its merits. In reply to Mr. Ayre, the author stated that the 12ft. space was not exceeded, and he also pointed out that there was no difficulty as regards trimming the bunkers between decks because the coal was simply placed on the deck and went almost straight down into the boiler-room. Even the most exacting coal trimmers would not ask for extra payment for trimming coal when it was simply placed on deck.

The second paper was by Mr. W. H. C. Nicholas, on "The Evolution of the Modern Steam Trawler with Superheating."

THE MODERN STEAM TRAWLER.

The first steam trawlers only fished local grounds, remaining away from port for a very few days. At that time, fish was plentiful and markets good. In the course of a few years, however, the local fishing grounds became over-fished and depleted, while the public demanded a greater variety of fish, with the result that the boats were forced further afield and their range had to be extended. This called for larger vessels with better sea-going qualities and of greater power, which were capable of staying away from port for much longer periods, and of towing the gear at greater depths. The early type of British steam trawler was about 90ft. long, an example of typical dimensions in the year 1890 being 88ft. length, 20ft. beam, and a depth of 10·7ft. These vessels had a block coefficient of 0·6, and could maintain a speed of 8 knots on a consumption of 5 to 6 tons of coal per day. The decks were of the flush type, there being no raised forecastle, and the engines were situated aft.

The boiler, which was of the "Scotch" single-ended type and had two plain furnaces, sometimes with a common combustion chamber, was fitted at the fore end of the engine-room between the side bunkers, and was fired from aft. The propelling machinery was a compound surface condensing steam engine which worked at a pressure of about 90 lb. to 120 lb., the cylinders being 17in. and 32in. diameter respectively with a 21in. stroke, and developed about 200 i.h.p.

Two men only were carried down below, each man taking turn and turn about in keeping a six hours' watch and also doing his own firing and trimming. As the boiler faced aft, it was easily accessible for firing from the forward end of the engine-room.

In the course of time larger boats were employed and ventured further afield until the time came when, during the war, the length of the long-distance trawlers, those fishing on the Iceland, White Sea, and Bear Island fishing grounds, reached about 140ft. By this time a definite building standard had been reached, so that when a boat was laid down it was built to a specified type, a fact which certainly helped to make for uniformity in the rapidly growing fleets.

The modern steam trawler is a vessel of over 160ft. long, typical dimensions of a large boat being 173ft. overall, 26ft. 6in. breadth moulded, and depth moulded 15ft. The vessel has a large sheer and very fine hull lines, with a consequent low block coefficient, in the region of 0·57 to 0·59. Special attention has been paid to the stern, which is streamlined and of the cruiser type. A streamlined rudder and sternpost are also fitted; these help to give improved performance and reduced helm action, and also enable a truer course to be maintained.

With the fitting of superheaters in these boats the necessity has arisen for the carrying of fresh water for the boiler, and in some cases double-bottom tanks of about 40 tons capacity have been fitted.

In comparison with the "Mersey" class boats, 1916, which burn 9½ to 10 tons of coal per day in order to maintain a speed of 10 knots, the new boats burn, on an average, 8½ to 8¾ tons per day for a speed of 11½ to 12 knots.

Steam is provided by a single-ended "Scotch" boiler, typical dimensions being 15ft. 6in. diameter and 11ft. long. The engines are triple-expansion, designed to run on superheated steam, and develop from 750 i.h.p. to over 900 i.h.p., the higher horse-power being developed by a higher speed engine, which runs at about 135 r.p.m., as compared with the 116–120 r.p.m. of the lower horse-power engine. The dimensions of a typical engine developing 800 i.h.p. are as follows:—14½in., 24in., and 40in. by 27in. stroke.

At present, the exhaust turbine is being tried on a new British trawler, this working in conjunction with a compound engine running on saturated steam. In Germany, however, superheated steam is being used in this connection, which not only takes advantage of the increased power output, but also effects economy in fuel. Nearly all the new trawlers in this country are being fitted with superheat, and some of the ships which were built in 1933 to run on saturated steam have now been converted.

As regards the degree of superheat employed, it has been ascertained that about 210 deg. are obtainable, but 190 deg. appears to be the usual working temperature, with a corresponding steam temperature of 580 deg. Fah., the boiler pressure being 210–225 lb. The funnel temperature of a steam trawler at the base is in the region of 700 deg. Fah., which accounts for the degree of superheat obtained with a simple and straightforward design of superheater. The smoke tube type is generally employed.

DISCUSSION.

Dr. S. F. Dorey remarked that in these days of intense competition between one country and another it was essential that in all branches of the shipping industry we should keep in touch with the most recent developments, and therefore it was particularly pleasing to note that the trawler people were giving thought to developments which had been taking place during the past year or two in connection with big ships. Commenting on the steam consumption per i.h.p. per hour, Dr. Dorey said that, so far as he could gather at the present time, the Bauer-Wach installation of the latest type could get down to between 1·1 lb. and 1·2 lb. per i.h.p. per hour, which was a very satisfactory figure considering the small size of the engines involved.

Dr. Dorey suggested that if the trawler owner proposed to install more modern machinery it was most essential that he should consider his staff. It was all very well to put in what might be termed the latest gadgets, but it was essential that proper care should be given to them.

Mr. W. Hoy said that as many trawlers were actually at sea for from 250 to 300 days per annum, there was little doubt that the fitting of superheaters would enable the annual fuel bill to be reduced by about 500 tons. With present experience of superheat, both in large and small craft, no apprehension regarding the employment of superheated steam need be entertained if a thorough job was made of the installation as a whole. The author had referred to the boilers in this class of vessel as having a specially large diameter in order to counteract as far as possible the tendency towards priming in heavy weather. It would be interesting to learn to what extent the steam space was given the benefit of this increased diameter, as normally a smaller boiler would serve for the same power when superheaters were fitted.

Appreciating the available standard of engine-room *personnel*, and also the hard service to which the machinery was regularly subjected, it was essential that simplicity and reliability should be regarded as of primary importance, and from that point of view

the straightforward triple-expansion machinery of robust design having h.p. cylinders fitted with independent steam and exhaust valves of the poppet type—admirably suited for the employment of superheated steam, at a temperature of about 600 deg. Fah.—would appeal to all progressive trawler owners and their superintendents.

The Author said that a Bauer-Wach installation was fitted in some of the latest British trawlers in the autumn of last year and one had proved very satisfactory, but the results obtained with those boats had been very difficult to find out, because they had been guarded very closely. Those boats were 150ft. by 15ft., and he believed that the coal consumption was about 8¾ tons per day for a speed of about 11½ knots. The suggestion by Mr. Hoy that advantage should be taken of waste heat by installing a tubular feed-water heater in the uptake had been discussed by various owners' superintendents, but they were not very favourably impressed with the idea. He believed it was generally considered that the pipe line to the feed-water heater would be too long and that the loads imposed on the feed pumps would be too great. It might, however, be practicable with an independent feed pump. As to poppet valves, he was not aware of any in use on British trawlers, although he rather expected the first one so fitted would come out this year.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

GOVERNMENTAL INTERFERENCE IN AMERICAN INDUSTRY.

SIR,—It is over four years since I last visited the United States of America, and it is almost impossible to realise fully the change that has taken place in that great country in such a short space of time.

The depression which had overhung Europe, and particularly Great Britain, prior to the advent of Mr. Roosevelt as President, had not fully affected the United States until the Wall-street crash of 1929. The depression which the United States is, and has for the last four or five years, been going through is a perfectly natural reaction to the orgy of speculation which was indulged in in the post-war years, and has been accentuated by the short-sighted policy of the American Government in its treatment of its war debtors.

My recent visit was an object lesson to me on the evils of State interference in industry, which I should think has reached almost maximum heights in the United States, and is only exceeded in Russia; but what struck me most about the American position and the work of the Roosevelt "Brain Trust" was what appeared to me as the amazing disregard of basic economic laws. In the midst of a financial crisis, the like of which the United States has never experienced before, Mr. Roosevelt and his Congress have seen fit to attack and shake to their foundations the great banks and financial institutions of the United States, and, whilst banks were closing through lack of confidence, largely inspired by the actions and words of the Government's supporters, big bankers and financiers were being interrogated like criminals before the Senate of the United States. Big industrialists have likewise been pilloried before this body, whose main object seemed to be to make "wisecracks" that appealed to their own more ignorant voters. The avowed antagonistic views of the present Administration to "big business," and the accompanying inquisitions which have been instituted by the Government, have succeeded in effectively stifling any new development of a material nature involving private capital outlay, which is the main cause at the present time of the vast unemployment figures which exist on an unparalleled scale in the United States.

It seemed to me when I visited the United States in March that conditions there were just about as bad as it was possible for them to be, but at that very moment the President thought fit to urge the enforcement of legislation through Congress, the effect of which was to assault and shock to their very roots the big gas, water, and electricity supply companies of the United States, to threaten them with municipal and governmental competition, and with plants which would be constructed by the unemployed, who would be paid wages at less than the accepted standard rates. This ill-considered and ill-timed attack coincided with a proposal to spend £2,200,000 per day for the relief of the unemployed. With one hand the President is creating unemployment by destroying capital values and confidence, and with the other he is attempting to relieve unemployment by means of a debt for posterity which has been unheard of in any peace-time period; that he is tearing down with his right hand and building up with his left is the inevitable conclusion I came to. My own belief is that the quack remedies he is applying to the sick industries of the United States, and the attempt which he is making to restore purchasing power by a wholesale distribution of doles is doomed to failure, for the very reason that most of the work which is being undertaken is of an entirely unremunerative nature.

This bad example of Government interference with private enterprise has probably never been exceeded, and it is small wonder that the thinking American public and the big business men with whom I discussed the situation were unanimously loud in their praise of the wonderful work which has been going on in our country since 1931. Many of them expressed great envy and said they only wished that their enterprises were located in Great Britain. It must be a source of satisfaction to every Englishman who travels to-day to record the admiration of foreigners for the way we are doing things here.

Another impression which I gathered during my travels through the Middle West and Southern States of America was that if only a measure of confidence could be restored by the cessation of continual Government meddling in business, a rapid revival in the business position would occur. The resiliency of the American population is well known, the immense home market for their manufactures is an accepted fact, and there is nothing to stop a tremendous revival in the United States by the psychological attitude adopted by the American public in general. A steady revival in the value of securities and an assurance from Government headquarters that business would be allowed to develop along natural lines would, in my opinion, bring about a tremendous revival throughout the country, and it will be interesting to see whether this does occur, in spite of the Government, in the near future. I am perfectly convinced that it would occur, and on a very large scale, if the United States was blessed with a Government with the breadth of vision and knowledge of business conditions possessed by the present British Government.

GEO. C. USHER.

April 17th.

CO-ORDINATED DEMECHANISATION.

SIR,—It is an indisputable fact that from earliest ages man has been a tool-using animal. In his struggle for existence this characteristic has played a predominant part. Even in those distant times primitive tools enabled man to perform more work than would have been otherwise possible. As intelligence and ability advanced, the science of Engineering developed, and I believe it is true to say that the engineer's contribution to humanity consists essentially in the ability it places at his disposal to perform an increasing amount of work with a decreasing amount of effort.

Through all past ages it has been an essential condition of existence that humanity should work. The truth, then, of the old saying "We work to live," is a fundamental one, and has become ingrained in the race, so ingrained that in some members it appears to have become distorted into "We live to work." It should not be necessary to point out to intelligent engineers that this perverted statement is not necessarily true.

Your correspondent Mr. C. R. King has made a comprehensive survey of the possibilities of the continued application of engineering to human affairs, and has correctly deduced that it is possible still to reduce those of man's activities referred to as "work" to an astonishing degree. He notices also that with each extension of mechanisation the customers for the production of this prolific system are progressively reduced. And then what does he propose? Tacitly assuming that we "live to work," instead of "work to live," he suggests "co-ordinated demechanisation."

After admitting that mankind has developed the talents and gifts of the Creater to such a remarkable degree that at any moment the world might shower material blessings, he suggests that mankind should put their fingers to their noses at the Creator and thereafter commence to destroy, bury, burn, and ravish His blessings before His face.

Was ever such blasphemy uttered? Was ever such insult suggested to the members of an honourable profession? "You engineers," he seems to say, "are a curse to your fellow men. You have shown him how he may live, nay, even thrive, with a minimum of effort, the gravest disservice to humanity yours." "Henceforth you must change your ways and show him how to make life more difficult. Turn back the clock, say, thirty years, and forget the electric motor, the acetylene torch, and the automobile; let us return to primitive sanitation and the like." Has it not occurred to Mr. King that humanity *wants* the abundance which is available, handed down to it as a legacy of the exertions of bygone ancestors, and that although disemployment at present means loss of purchasing power, it still only requires an organisation of distribution to ensure that mankind *gets* what he wants?

And if Mr. King prefers not to take his share, well and good, let him do without; nobody will mind. Let him bound blithely up ten flights of stairs instead of using the elevator; let him walk (or even crawl, an he prefers it), 100 miles to deliver a letter to the Editor, instead of using the train or aeroplane; let him reject the optician's skill if he should be shortsighted; let him walk to the village pump when he seeks refreshment, and find enlightenment by the aid of a "tallow dip." Such are the possibilities for activity open to those who believe that we "live to work."

All men of sense will reject such ideas, and insist that the bounty of Nature be made available in an increasing degree to all. "It cannot be beyond the power of man so to *use* the vast resources of the world as to ensure the material progress of civilisation." So speaks a *real* King—his Majesty George V—at the opening of the Economic Conference. Let men of good sense and good will hasten to devise and apply the appropriate remedy ere it is denied them.

C. W. RYDEN.

Glasgow, April 21st.

A FACTORY for the manufacture of chains is opening at Vereeniging, in South Africa. It will consume at the outset some 1000 tons of steel per annum.

A New Monel Alloy.

ENGINEERS and metallurgists have long been familiar with the valuable properties of the alloy known as "Monel metal." As the result of twelve years' laboratory study and production development, a new form of this alloy in which mechanical properties similar to those of alloy steels may be obtained by simple heat treatment has been produced. This new alloy is called "K" Monel metal, and is characterised by the addition of aluminium. In the soft condition it has a hardness of approximately 140–150 Brinell, but by heat treatment alone this hardness can be increased to over 260 Brinell, while by a combination of cold work and heat treatment hardnesses of 320 Brinell or more may be obtained.

Henry Wiggin and Co., Ltd., Millbank, London, the suppliers, have provided us with the following details of its properties:—

Physical Constants.

Density	8·58
Weight, lb. per cubic inch	0·31
Melting point	1,315–1,345 deg. Cent.
Specific heat (20–400 deg. Cent.)	0·127
Coefficient of expansion—	
25–100 deg. Cent.	0·000014 per 1 deg Cent.
25–300 „	0·000015 „ „
25–600 „	0·000016 „ „
Magnetic transformation	Below minus 79 deg. Cent.
Elastic modulus—	
In tension	26,000,000 lb. per sq. in.
In torsion	9,500,000 „ „

The alloy is non-magnetic under ordinary working conditions, and remains so at sub-normal temperatures. No measurable difference in its magnetic permeability in the soft and fully hardened condition has been found. This non-magnetic quality should render the alloy particularly valuable in instrument, aircraft, and radio work.

MECHANICAL PROPERTIES.

"K" Monel metal can be supplied in three different conditions:—(*a*) As hot rolled and softened; (*b*) as hot rolled, softened and thermally hardened; (*c*) cold worked and thermally hardened.

Typical properties for these three conditions are:—

Condition.	Ultimate strength, tons per sq. in.	Yield point, tons per sq. in.	Elongation, % on 2in.	Izod, ft./lb.	Brinell.
Hot rolled and softened	89	19	35	100	140
Hot rolled, softened, and thermally hardened	60	43	30	70	270
Cold worked and thermally hardened	72	60	15	50	320

In the fully heat-treated condition it will, we are informed, carry an alternating stress of 17½ tons per square inch for 10,000,000 reversals without fracture.

STRENGTH.

The following table gives the strength at elevated temperatures, determined by short-time tensile tests, of cold-drawn and heat-treated rod:—

Temperature, deg. Cent.	Maximum stress, tons per sq. in.	Yield point, tons per sq. in.	Proportionality limit, tons per sq. in.	Elongation, % on 2in.	Reduction in area, per cent.
25	72·6	55·8	46·9	21·0	38·9
95	72·8	55·4	46·4	21·0	37·0
205	69·6	52·7	44·6	20·0	35·0
315	65·9	48·5	37·5	19·5	32·8
425	55·8	47·3	36·3	18·5	29·8
540	55·6	45·9	31·5	9·5	9·8

As yet full determinations of creep strength have not been carried out, but the following results will give some idea of the behaviour under prolonged stress. Specimens of rod which had been cold-worked and heat-treated to give a Brinell hardness of 285 sustained a load of 30 tons per square inch at 400 deg. Cent. for three weeks without showing any measurable creep. In the case of fully heat-treated rod, having Brinell hardness of 240, which had not been cold worked, a load of 20 tons per square inch was sustained for three weeks without showing any measurable creep.

HEAT TREATMENT AND MACHINING.

To soften "K" Monel metal, it should be heated to a temperature of approximately 800 deg. Cent. for a sufficient time to ensure complete soaking, and be quenched in water or oil.

To harden, the material should be reheated to a temperature of 590 deg. Cent., and slowly cooled. The degree of hardness developed varies to some extent with the time of exposure at this temperature. Four hours is generally sufficiently long to develop practically full hardness, but slightly increased hardness results from holding at this temperature for six or eight hours. The hardening treatment can be applied to softened, hot-rolled, or cold-worked material.

In the softened condition or moderately hardened (up to 270 Brinell) it can be machined at almost the same speeds and feeds as for mild steel, provided good quality high-speed steel tools are used. In the work-hardened plus thermally hardened condition (Brinell 280–330, or even higher), Widia or similar tools are usually necessary, but this can be avoided by machining before final thermal hardening.

The "Sip" Hydroptic A Machine.

By JOHN HOLLOWAY.

THE original "Sip" precision boring machine, constructed by Société Genevoise, 5-6, Brettenham House, Strand, W.C.2, is now well known and description is unnecessary. There are upwards of nine hundred of this type, operating at present in many parts of the world. But though these machines have exceptional merit, particularly as regards

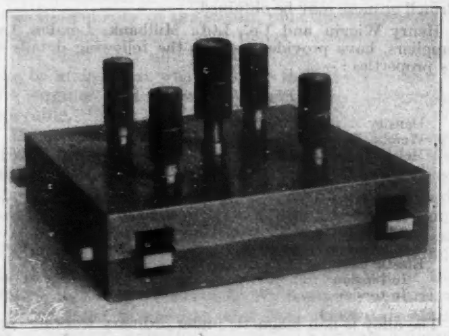


FIG. 1—TEST OF ACCURACY

setting and positioning facilities, and function perfectly on the class of work for which they were designed, it must be recognised they are intended for locating, drilling and boring only, and not for milling, so that a new set-up of the piece is necessary whenever milling operations are required. On this account

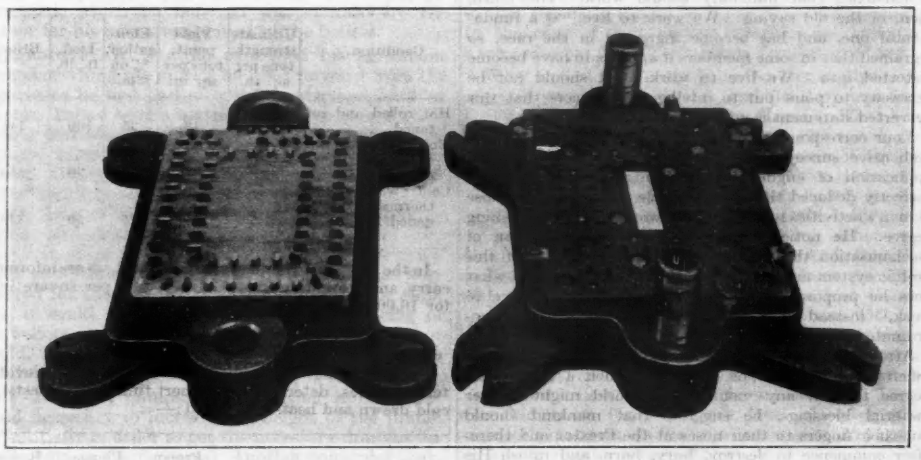


FIG. 2—PUNCH AND DIE PLATES DRILLED AND MILLED ON HYDROPTIC A MACHINE

there is danger of accuracy being sacrificed, while loss of time, due to resetting the work, is incurred. In the "Sip" Hydroptic A both these disabilities are removed.

In the development of this machine several essential conditions had to be fulfilled. They may be summarised thus:—

(1) To retain permanency of accuracy, in spite of heavy mechanical stresses.

(2) To maintain high efficiency over an adequate range of speeds and feeds, combined with easy and positive control.

As regards accuracy, a very exacting test has been imposed—see Fig. 1. As will be noted, two separate pieces have been milled and bored, placed face to face, then plug and slip gauges inserted as shown, as the tolerance on the gauges is as low as 0·0002in., the high degree of accuracy obtained will be appreciated.

A further proof of the extreme accuracy obtained is given in Fig. 2; the punch and die plates shown having been drilled and milled on the Hydroptic A machine. The centre distances were duplicated solely by the use of the optical measuring device fitted to the machine, and without any other check measurement.

PERMANENCE OF ACCURACY.

To ensure permanent accuracy these considerations were applied. A micrometer screw will retain its original accuracy so long as it is only required to overcome the frictional resistance of the work table sliding on well-lubricated bed ways, but it will not withstand the severe stresses imposed by heavy milling operations. An optical measuring system consisting of a standard scale of extreme precision and sighted by a micrometer microscope with a large magnification, represents the ideal method of setting. It is not subjected to mechanical stresses, and therefore retains its absolute permanent accuracy.

A measuring device of this character, which hitherto has only been applied to high precision instruments, comprises delicate components which have to be carefully guarded to withstand ordinary workshop conditions, such as oil and dirt or careless handling. The Société Genevoise has therefore given them full protection against damage by entirely enclosing them, this having been made possible by an ingenious patented design of scales and microscopes.

The standard scales are covered by heavy protectors, which are integral with the work table and spindle saddle, the movement of which they are to measure. The scales are inaccessible, the graduations being enclosed and hermetically sealed by the internal faces of the scales and the surfaces on which they slide. Fig. 5 is a sectional view showing the table scale arrangement. The scale A of the table is surrounded by the protector B and is pressed against the face of the bed C by a series of small springs D. The graduated surface is at E. Both the extreme ends of the scale are provided with closing plates containing oil-soaked felt packing, ensuring the lubrication of the surface F by producing an oil film, thus making the joints entirely dustproof. The oil is constantly renewed by way of the hole G through the V ways of the bed. Wicks in these holes serve to filter the oil during its passage, while the inclined surfaces H prevent oil from flooding the graduated surface of the scale by directing it to the joint face.

Sighting the scale is taken through the aperture K, which is closed by a lens. The air contained in the space around the scale is entirely shut off from the outside atmosphere, so that it is impossible for grit or dirt to enter. This has been proved by exacting tests which have been made by projecting dust and

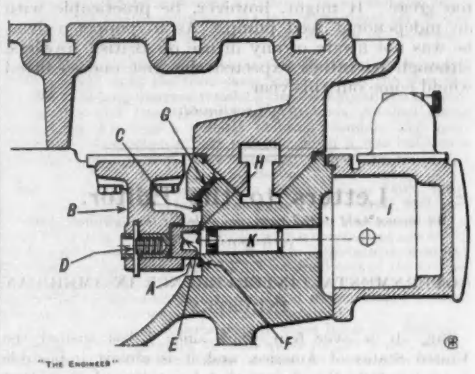


FIG. 5—TABLE SCALE ARRANGEMENT

vaporised liquids under pressure. These tests have shown very conclusively the perfect air and dust-tightness of the design.

When discussing a microscope arrangement attached to a machine tool, one may be inclined to think of some fragile mechanism that is unsuited to the everyday wear and tear of the ordinary machine shop, but, as already indicated, extraordinary care has been taken to ensure freedom from injury and permanence of use for this important part. The microscope body is actually constituted by the machine bed itself, and the only accessible element is the eyepiece. Fig. 3 shows the table microscope protected during loading of work, and when milling. Fig. 4 shows the microscope in the working position.

In this patented construction the bracket supporting the eyepiece can be tilted so as to lie below the table level and so permit the unobstructed loading of heavy work, as seen in Fig. 4. In this position the eyepiece is covered by a protecting shield. It should always be protected thus during milling operations, to guard against damaging the outer glass protecting cover, though this is very easily replaced should it become scratched by repeated cleaning. Moreover, two spare glasses are supplied as regular accessories.

The eyepiece bracket is pulled back into its working position by a spring-loaded device, but the exact positioning is of no importance, and has no influence on accuracy of measurement; indeed, the bracket may be tilted through more than half an inch with-

FIG. 3—TABLE MICROSCOPE PROTECTED

FIG. 4—MICROSCOPE IN WORKING POSITION

out any alteration of the reading in the microscope. All these parts have been made very strong and do not require to be handled with any special care.

To emphasise the utility of these remarkable features still further it can be said that the whole

design is so rigid that no vibration or shock on the microscope can alter the settings made.

The measuring method on the Hydroptic is even simpler than on the jig borers of former types. In the latter the approximate setting of the table is read with the naked eye by means of a reference index and a scale mounted along the bed of the machine, and the final setting obtained on a micrometer drum and vernier, attached to the lead screw. In the case of the Hydroptic there is near the microscope a graduated drum—seen in Fig. 4—divided into 100 parts. To set the table, for

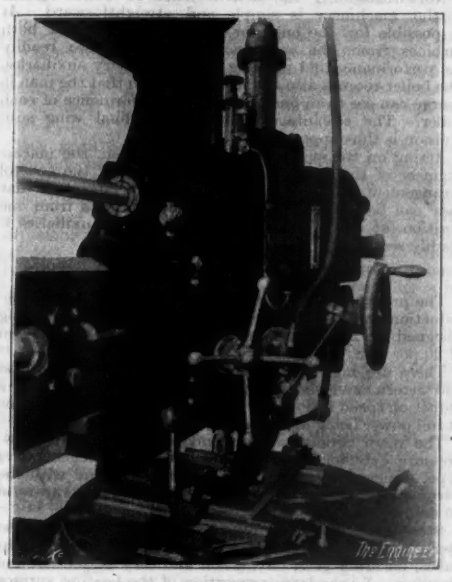


FIG. 6—HIGH-SPEED BORING HEAD

example, to the position 32·6525in. it is first traversed hydraulically until its index on the visible scale is between the numbers 32·6 and 32·7, while the divided drum is set to number 525. When sighting in the microscope, the dotted line of the microscope recticle appears in the neighbourhood of a plain line of the table precision scale. Then by means of the slow-motion hand wheel the table is moved until the dotted line and the plain line are exactly superimposed, which then gives the exact measurement desired.

To render the reading of the bed scale still easier the latter is equipped with an adjustable reference index, which can be set in the desired position for the next setting, while the work is in progress. The positioning of the table is then accomplished by making its own index coincide with that of the scale, this operation being more convenient than to watch the table index travelling along the scale.

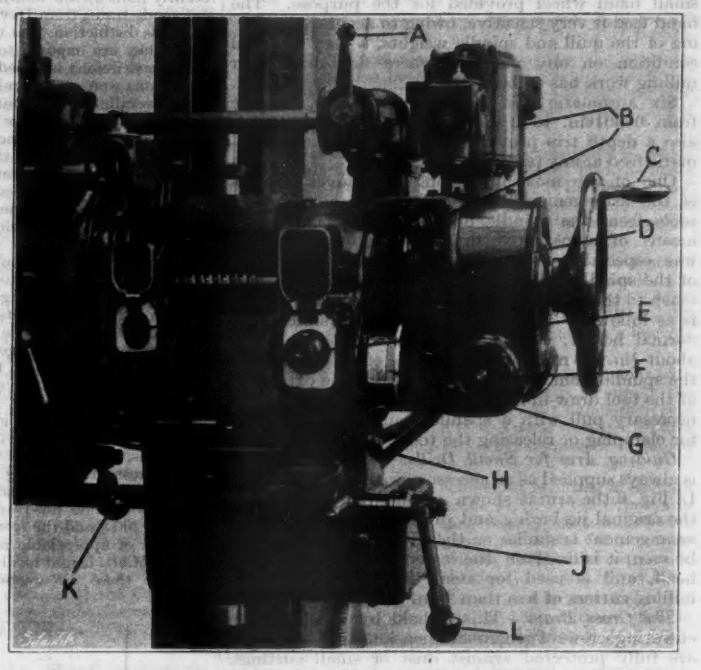
Table Drive.—Hydraulic drive to the table is employed because it permits of wide and immediate variations in speed of travel, and because of its simplicity in operation. Milling feeds can be chosen at will, but, more important still, the table can be traversed rapidly to the approximate position required for drilling and boring. The table can be power traversed over its full stroke in thirty seconds, or can be reduced down to 0·05in. per minute in a stepless reduction, according to the position of the control lever. Manipulation is so sensitive that after a few minutes' training an inexperienced operator is able to bring the table to a dead stop to within a thousandth of an inch of the position required.

The hydraulic drive is interconnected with the mechanism for the final setting of the table, and locking it on the bed ways. The hand wheel for fine setting can only be operated when the hydraulic drive is disengaged, and the locking lever released; likewise, the hydraulic power cannot be applied while the table is locked on its ways. The interconnection of the whole mechanism is so complete that the possibility of faulty operation is entirely eliminated.

Table speeds are determined by means of the control lever, the hub of which is graduated. A further positive control is provided in the form of a knob placed at the centre of the control lever hub; this has two main positions. In the first, the table is brought instantly to rest when the operator releases the lever. This is the position used for setting the table at any point on the bed ways. But with the knob moved to the second position, the lever remains in place and the table is traversed at the rate selected for milling work.

The outstanding features of the hydraulic drive, as applied to the Hydroptic A machine work table, are the positive control of its speed of movement, the precise preselected position at which it can be brought to rest, and the simple mechanism by which it is controlled.

Spindle Head.—To resist the heavy stresses associated with rapid milling and boring operations, the spindle head is of very rigid design. It embodies many important features, such as: Long feed travel (10in.), fitted with automatic trip; special bearings for taking the thrust when milling without incurring fatigue, and quick raising or lowering of the spindle, with counterweight for static balancing;



A—Lever, Disengaging Power Drive to Permit of Slow Hand Rotation of Spindle.
B—Electric Motor and Switch for Transverse Milling Feed.
C—Rapid Hand Traverse of Saddle.
D—Knob for Setting Standard Scale to Zero Point.
E—Eye Piece for Optical Readings.
F—Slow Hand Motion for Accurate Positioning of Spindle.
G—Micrometer Drum of Microscope.
H—Reference Index for Approximate Setting.
J—Switch for Power Movement of Cross Beam.
K—Lever for Clamping Saddle to Cross Beam.
L—Lever for Locking Cross Beam to Both Uprights.

FIG. 9—OPERATING END OF CROSS BEAM

wide range of speeds from 40 to 1250 r.p.m., a patented device for clamping and releasing the tools from the spindle nose, and efficient protection of the spindle and quill, eliminating all soiling of the bearing surfaces, and simple operation and automatic lubrication of all moving parts.

All controls are within easy reach of the operator, and the feed dial directly faces him.

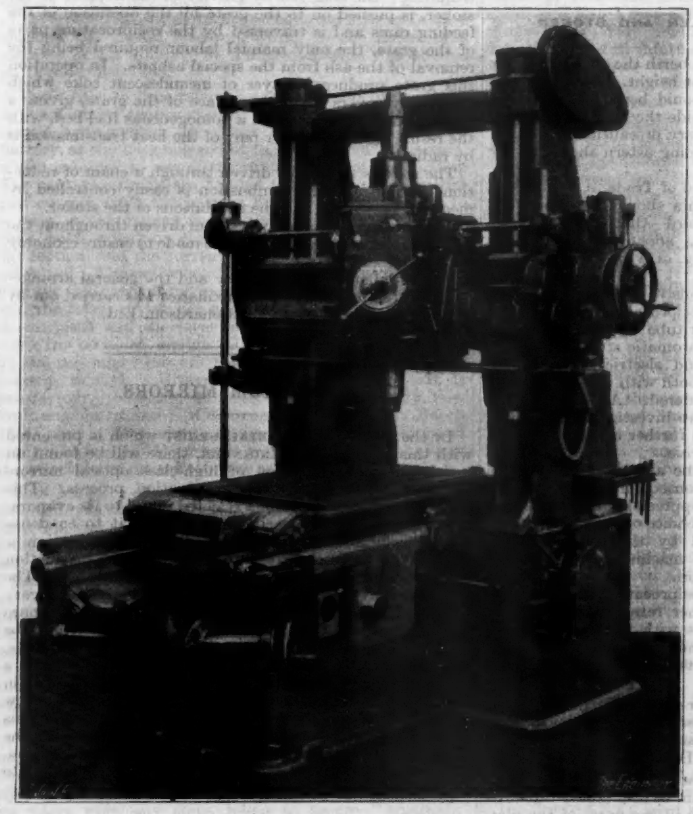


FIG. 7—OPERATING SIDE OF MACHINE

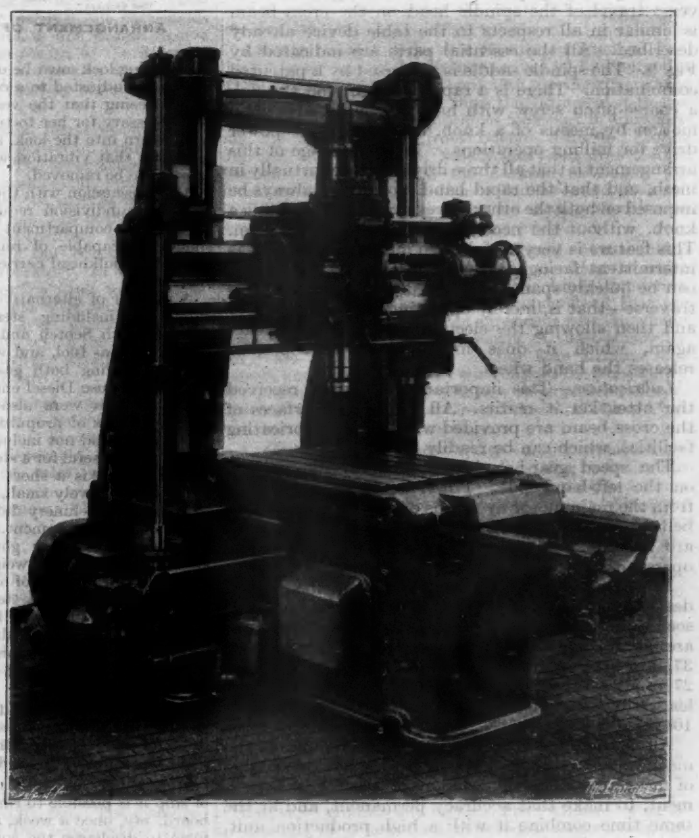


FIG. 8—DRIVING SIDE OF MACHINE

A few notes on the construction and control of the spindle head will be of interest, and will show the care and thought that has been exercised in the detail of the machine.

The Spindle.—This is mounted on three special bearings of great accuracy and of ample dimensions,

capable of withstanding years of work without perceptible wear. They are interchangeable and are provided with automatic axial play compensation.

The Spindle Quill.—Is made of case-hardened steel, and is automatically cleaned by a special device located on the spindle base. Slow or rapid hand feed is obtained by operating a capstan lever or a small hand wheel provided for the purpose. The hand feed is very sensitive, owing to accurate balancing of the quill and spindle weights, a very essential condition on any machine where fine drilling or milling work has to be done.

Six automatic feed rates are available, ranging from 0·0016in. to 0·01in., up or down. There is also a depth trip provided for cutting out the automatic feed at any point desired.

One of the most interesting and novel features is the arrangement for securing and ejecting the tools from the spindle nose. This is effected by means of a patented draw-in rod device, which was especially developed, because the dimensions of the spindle are such as would not permit of easy reach to the upper end. The operation of this feature is as follows:—The spindle, when fully raised to its normal height, can be given an additional lift of about $\frac{1}{2}$in. (20 mm.), which has the effect of releasing the spindle from its driving gear, while the extremity of the tool draw-in rod is automatically locked. The necessary pull with a spanner can then be exerted for clamping or releasing the tools.

Guiding Arm for Small Drills.—The guiding arm is always supplied as an accessory with every machine. In Fig. 6 the arm is shown mounted in position on the original jig boring and drilling machine, but the arrangement is similar on the Hydroptic A. As will be seen, it is fixed on the lower part of the spindle head, and is used for small twist drills and end milling cutters of less than $\frac{5}{16}$in. (8 mm.) diameter.

The Cross Beam.—This is held by two precision elevating screws of generous dimensions and the threads are fully protected against dust or small cuttings. Its vertical motion is controlled by an electric motor, and a graduated scale is fixed to the right-hand upright to indicate its vertical position. A new and patented locking device is incorporated in the design, and is actuated by a single lever from the operator's working position. The value of this locking device is that it ensures a powerful and well-distributed clamping action at both ends of the cross beam, and at two points on each upright. The total clamping pressure is eight tons, there being three tons on each of the top positions and one ton on each of the bottom positions. The tightening of the clamping lever automatically cuts out the electric power drive, and provides a sure protection against faulty operation. A further safeguard is introduced in the form of automatic stops, which cut out the drive at each end of the vertical traverse, thus eliminating all danger of overrunning.

The optical equipment for measuring the transverse travel of the spindle head on the cross beam is similar in all respects to the table device already described. All the essential parts are indicated by Fig. 9. The spindle saddle is traversed by a patented combination. There is a rapid hand motion through a coarse-pitch screw with hand wheel, a slow hand motion by means of a knob, and an electric power drive for milling operations. The advantage of this arrangement is that all three drives remain virtually in mesh, and that the rapid hand motion can always be imposed on both the other drives by merely operating a knob, without the necessity of disconnecting them. This feature is very useful when milling work that has intermittent facings, the spaces between the facings can be quickly spanned by the use of the rapid hand traverse—that is, merely operating the hand wheel—and then allowing the electric drive to take control again, which it does immediately the operator releases the hand wheel.

Lubrication.—This important matter has received the attention it merits. All the sliding surfaces of the cross beam are provided with central lubricating facilities, which can be readily attended to.

The speed gear-box is mounted on the upright on the left-hand side. Power to it is transmitted from the main motor by means of a triple "Texrope" belt driving through a friction clutch. All the controls are localised and placed within easy reach of the operator.

In appearance the machine is robust, the general design indicating strength and rigidity, as will be seen in Figs. 7 and 8. The general overall dimensions are as follows:—Table, 39$\frac{1}{2}$in. by 27$\frac{1}{2}$in.; travel, 37$\frac{1}{2}$in.; maximum height of nose from face of table, 27$\frac{1}{2}$in.; travel of head on cross bar, 24in.; total length of machine, 108in.; width, 92$\frac{1}{2}$in.; height, 104$\frac{1}{2}$in.

Altogether, the machine is a fine example of the machine maker's art. To produce a machine capable of measuring with the accuracy of a scientific instrument, to make that accuracy permanent, and at the same time combine it with a high production unit, is a great achievement.

ANSWERING a question addressed to him on April 9th, Mr. Hore-Belisha said that the number of persons killed in road accidents in Great Britain per 100,000 of the total population was 15·9 in 1933 and 16·2 in 1934.

Train Ferry Steamers for the S.R.*

By Sir WESTCOTT ABELL.

VARIOUS forms of vessels to carry trains are not uncommon, but generally they are used on lakes and inland seas with limited regions of operation. The vessels recently built for the Southern Railway to carry passenger and goods trains from Dover to the French Channel ports have this distinction, that they have to operate on services where they are exposed to full sea-going conditions.

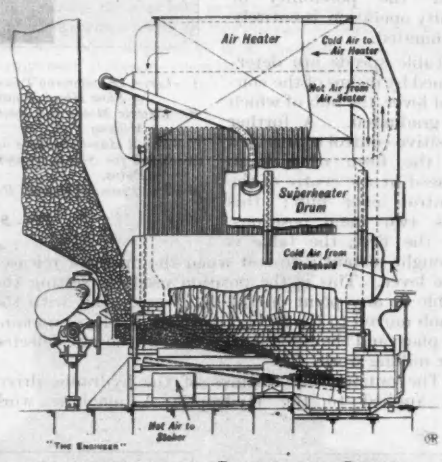
The restrictions imposed by the service on the vessels' dimensions were considerable. The length was limited to 360ft. overall, the maximum breadth over fenders to 63ft., and the draught of water to 12ft. 6in., ordinary loading. As a further restriction the height of the train deck above water was 7ft. 6in. from the ordinary load line, and thus the moulded depth was only 20ft. A speed of 16$\frac{1}{2}$ knots was required, and a coal consumption trial of six hours at that speed had to be carried out. In addition, the engines were required to be capable of obtaining revolutions astern which were 85 per cent. of those corresponding to 16$\frac{1}{2}$ knots ahead, which revolutions were limited to 200.

The train decks had to accommodate twelve sleeping cars and two baggage wagons, or alternatively forty 25ft. goods wagons on four sets of rails. Two platforms were required, one on each side of the ship, between each pair of tracks, so that passengers could alight and have access to the accommodation on the deck above the trains. The necessary access to the machinery spaces had to pass through these platforms.

The maximum deadweight to be carried, apart from the weights necessary for the operation of the ship in average conditions, was 1200 tons.

The question of loading and discharging the trains from the ship required consideration, having in view the difference in tide level at Dover, which might vary as much as 20ft., and the fact that Dover Harbour is subject to swells of appreciable magnitude in certain conditions (a swell of 6ft. height has been measured).

Under these circumstances it was decided that an



ARRANGEMENT OF BOILER AND STOKER

impounding lock must be used to berth the ship, the water level being adjusted to a constant height. With this provision, seeing that the vessel should berth stern first, it was necessary for her to turn inside the harbour and proceed astern into the lock, and every precaution was taken to ensure that vibration when going astern should as far as possible be removed.

After discussion with the Board of Trade, it was agreed that the subdivision requirements should be equivalent to the two-compartment standard—that is, the vessel should be capable of remaining afloat with any main transverse bulkhead carried away, or with the equivalent thereof.

A number of alternative propulsive arrangements were examined, including steam reciprocators and geared turbines with Scotch and water-tube boilers using both coal and oil as fuel, and with automatic stokers with the turbines having both geared and electric drives, while proposals to use Diesel engines both with direct and with electric drives were also considered. At least twelve different types of propulsion were investigated, and even this number did not include two further economies which might prove useful for a steam drive.

The voyage is a short one, the amount of fuel to be carried is relatively small, and consequently the variation in choice of machinery did not appreciably affect the cost of the hull and equipment. The choice of the most suitable type was principally governed by the following considerations:—(i) The weight of machinery, (ii) the first cost, and (iii) the cost of operation.

It was clear that a steam reciprocator, whether with coal or oil as fuel, was for other reasons not generally suitable. It was clear also that with water-tube boilers fitted with heat economisers and automatic stokers the fuel costs were less with coal, than with oil. The final selection lay between:—

(*a*) Steam turbines and water-tube boilers, using coal as fuel with automatic stokers and with mechanical gear in preference to electric drive; and

(*b*) Oil engines (direct driven Diesels).

Here it may be stated that owing to the peculiar type of ship it is possible to run a train of coal trucks direct on board, say, once a week, and by lifting parts of the platform to discharge the coal by tipping into the bunkers, which were designed so that the coal is fed by gravity direct into the hoppers of the automatic stokers, resulting in considerable savings in handling.

Moreover, the cost of coal for use with automatic stokers is comparatively low, and thus compares more than favourably with the price of oil fuel.

It must also be remembered that absence of vibration, noiseless running, and power going astern were important factors to be considered, while reliability in operation and maintenance of machinery in service are weighty factors for railway traffic.

The choice, therefore, of a steam drive with single-reduction turbines and with water-tube boilers with automatic stokers and automatic bunkering, was justified on all counts.

In the interest of coal economy it was decided, further, to fit the water-tube boilers with air heaters and to use the closed stokehold system. It may be observed, however, that only a moderate degree of superheat was provided, principally because it was desired to make the propulsion system as simple as possible.

Notwithstanding the lack of head-room, the lay-out of the machinery is simple and straightforward. It is possible for the engineer in charge to control both turbines from the same position and to see readily the performance and working of the necessary auxiliaries. The boiler-room is also simply disposed, so that the man in charge can see from one position the performance of each boiler. The advantage of the longitudinal wing subdivision is thus apparent.

Acting on the suggestion of Mr. McQueen, the marine engineer of the Southern Railway at Dover, the control arrangements of the two turbines were arranged so that they can be individually operated by one man from one position, at which the working of the main auxiliaries is readily seen.

MACHINERY.

The propelling machinery consists of two sets of single-reduction turbines operating twin screws, each set being designed for 2500 s.h.p. and being capable of an overload of 20 per cent.

There are high and low-pressure turbines both ahead and astern, and these drive a single gear wheel with a reduction speed ratio of 17·56 to 1, the turbine revolutions at full power being 3550 per minute.

The main condensers are underslung below the low-pressure cylinder casing. They are of the regenerative type, designed to maintain a vacuum of 28$\frac{1}{2}$in. with the barometer at 30in. and with a sea water temperature of 65 deg. Fah.

Steam is generated by four Yarrow boilers of the latest type, having large steam and water drums with straight tubes, ensuring good circulation and easy inspection and cleaning. A very large proportion of the heating surface is exposed to direct radiant heat, and the furnace is of sufficient capacity to ensure complete combustion. There is a small superheater designed to give 100 deg. Fah. superheat, recessed on one side of the tube space. On the upper part of the boiler there is a large air heater of the horizontal type, through which the air passes from the stokehold round the boilers to the underside of the mechanical stoker. Each boiler unit is designed to evaporate 16,000 lb. steam per hour (with an overload of 20 per cent.) at a working pressure of 250 lb. per square inch and a total steam temperature of about 500 deg. Fah. with a feed water temperature of 270 deg. Fah. The air heater is designed to supply the air below the stokers at a temperature of between 350 deg. and 400 deg. Fah.

The closed stokehold system is used, the air being supplied direct to the stokehold by two forced draught fans which can work up to a pressure of 6in.

The mechanical stokers were made by the Taylor Stoker Company, and the bunkers are so arranged as to be self-trimming; the coal, fed by gravity to the hoppers of the stoker, is pushed on to the grate by the operation of the feeding rams and is traversed by the reciprocating parts of the grate, the only manual labour required being the removal of the ash from the special ashpits. In operation this grate produces a layer of incandescent coke which practically covers the main surface of the grate, giving a short flame combustion and a homogeneous fuel bed, with the result that the greater part of the heat transmission is by radiation.

The stokers are motor driven through a chain of reduction gearing, and the combustion is easily controlled by means of air supply and the revolutions of the stoker.

The auxiliary machinery is steam driven throughout the ship, and special arrangements are made to ensure economy in the auxiliary service.

The installation of machinery and the general arrangements of the machinery and auxiliaries was carried out by Swan, Hunter and Wigham Richardson, Ltd.

* Institution of Naval Architects, April 11th, 1935. Abridged.

ALUMINIUM MIRRORS.

IN the issue of THE METALLURGIST which is presented with this copy of THE ENGINEER, there will be found an article on the production of high-class optical mirrors by what is known as the evaporation process. This process consists in heating a selected metal to its evaporation temperature, in vacuo, and causing it to condense upon the surface which it is desired to treat. Aluminium has proved to be an admirable metal for the production of mirrors and the results attained are astonishing. The surface is not only highly reflective, but it tarnishes very slowly and can be cleaned by the application of pure soap and water. Hence, the actual surface itself may be used in astronomical telescopes and for similar purposes. The technology of the process has been carried to such a degree of perfection that a telescope mirror 100in. in diameter has recently been produced in America. Now that the workshop problems have been solved, it seems extremely probable that the coating of surfaces by the evaporation process for protection, or ornamentation, or specific scientific purposes, may become a quite important industry.

AN order has been placed in Canada for what are probably the three largest wooden storage tanks of their kind. They comprise three closely grouped ground wood storage and blending tanks, 34ft. in diameter and 56ft. high, and on account of their unusual height will require some 78 tons of steel bands. The estimated cost of these tanks is 75,000 dollars.

Rail and Road.

ACCORDING to the monthly progress report of the Society of Motor Manufacturers and Traders, there are at present 2,012,714 vehicles in use in this country, as against 1,789,336 a year ago.

WE have reason to believe that the Southern Railway electrical services to Eastbourne, Hastings, and Seaford will be opened, with the summer train services, on July 7th. The journey time from London to Hastings will be reduced by seventeen minutes, and the number of trains increased by twenty-five a day.

WHEN the Minister of Transport opened the Leckwith Viaduct at Cardiff recently, he said that there are fifty-four toll roads and seventy-two toll bridges still remaining in private ownership in this country, and to encourage their removal, wherever the public convenience can be assisted, he is willing to make grants from the Road Fund.

THE April issue of the *Railway Magazine* gives the interesting information that the Great Western Railway, in its 261 miles between Paddington and Fishguard, cuts across the boundary line of eleven counties no fewer than twenty-one times. There are eleven crossings of the Carmarthenshire-Pembrokeshire boundary in 6 miles, and two of these are within 10 yards of each other. Clynderwen station is at this point, and the waiting-room is on the dividing line, so that part of the building is in one county and part in another.

HEREIN, on March 8th, we recorded the derailment on February 25th, at Evesham, on the London, Midland and Scottish Railway, of a passenger train, as a consequence of which the driver was scalded to death. The inquest was adjourned until April 12th, and on its resumption the jury returned a verdict of "Accidental Death," with a rider that suggested that the permanent way was defective. As also related in our previous notice, the accident was inquired into by Colonel Mount on March 6th, so all the facts will probably soon be known on the publication of his report.

THE death, on April 13th, of Sir William Marwood, removed a man of unusually charming personality. While the last four years of his official career were spent in the Ministry of Transport after its formation in 1919, and where he was Director-General of Public Services and General Purposes, his work at the Board of Trade, as Secretary of the Railway Department, was the activity by which he was best known. He there most ably performed those duties which it was considered to be the responsibility of the Board of Trade; that is, to act, without bias towards either side, as intermediary between the railway companies on the one hand and traders and the public on the other.

THE recent closing down as an hotel, and its new use as offices for the railway company, of the Midland Grand Hotel, St. Pancras, may be said to have been anticipated two years ago. In March, 1933, Sir Josiah Stamp, the L.M.S. president, speaking at the annual dinner of the Royal Institution of British Architects, said, of the Great Hall at Euston, which was designed by Hardwick, that with the pressure of economic stress its glory had lately departed. Sir Josiah added that he was troubled about the St. Pancras Hotel, a building that was obsolete as an hotel and useless for offices. It was designed by Sir Gilbert Scott, grandfather of Sir Giles Scott, the architect of Liverpool Cathedral, during an enforced stay in London through the "dead" season, owing to the illness of a member of his family. St. Pancras Station was opened on October 1st, 1868.

FROM time to time references are made to track circuit as a safeguard against railway collisions. This is a very simple arrangement, the basis of which is a primary battery, at the outgoing end of the track circuited section, which is joined to one of the running rails of the section. The contiguous rails are bonded together by a light wire and current from the battery flows through the rails to a relay at the ingoing end of the section. The relay, in turn, holds a lock on the lever of the signal for entering the section, and the current returns to the battery by the other rail. The presence of a vehicle in the section short circuits the current by means of the wheels and axles, and the relay, which has allowed the lever to be free, is de-energised and the lever is held so that no train may enter the occupied section. It will be obvious that sand on the rail might prevent the vehicle short circuiting the current, and that always has been a difficulty. It is satisfactory, therefore, to report that the twenty new tank engines of the L.M.S., mentioned herein on March 15th, have a de-sanding arrangement whereby the sand applied in front of the wheels is washed off the rail after the wheels have passed over the sand.

THE Minister of Transport, when, on April 11th, he unveiled the model of the "Rocket" at the Science Museum, was over sanguine when he suggested that the death of Mr. Huskisson at the opening of the Liverpool and Manchester Railway on September 15th, 1830, "had perhaps stimulated Parliament to provide that the new form of transport should be accompanied at every stage by adequate precautions for the public safety." Mr. Huskisson was killed by, to use the phrase of the modern accidents reports, his own want of care, in that he crossed, from the side of the line, over what is now the down line, to shake hands with the Duke of Wellington who was in the special on the up line. When standing at the door of the carriage he was foul of the down line on which the "Rocket" was approaching. The latter engine struck the carriage door and Mr. Huskisson was thrown on to the down line and run over, receiving such injuries that he died a few hours later. Not for another ten years were any steps taken to secure "adequate protection for the public safety." Following a recommendation by the Select Committee of 1839 on Railway Communication the Regulation of Railways Act of 1840—3 and 4 Vic. c 97—called for returns of railway traffic, "as well as of all accidents which shall have occurred thereon attended with personal injury." It may be added that the "six foot" between the two running lines was one of only 4ft.; that the special carriage projected 2ft. into this space, and the carriage door overlapped the down line by 6in.

Miscellanea.

THE Hetch Hetchy Dam, which was described in THE ENGINEER of April 6th, 1934, is 344·5ft. from the lowest point of its foundation to its crest, and plans have been approved by the United States Secretary of the Interior to heighten it to 429·5ft. The additional 85ft. will increase storage capacity 69 per cent.

TWO technological representatives of the Provincial Government of Shansi, China's coal area, were taken over the low-temperature carbonisation plant at Askern, near Doncaster, and Barugh, Barnsley, to inspect the processes in operation, with a view to an installation of their own. The Shansi Government wishes to have locally produced supplies of fuel for motor vehicles, heavy oil engines, and lubrication, and is considering the possibilities of setting up a plant treating between 150 and 200 tons of coal a day.

AS a permanent memorial to the King's Jubilee, the United Steel Companies, Ltd., after consultation with representatives of the works councils of the various branch companies, and with their full agreement, decided that in lieu of any holiday or holiday payments there should be established convalescent and holiday homes for employees and/or cottage homes for retired employees. The money available for the purpose will be at least £10,000, and may exceed this sum. The final details of the scheme have yet to be decided and approved by the board, and the final decision will be taken early in May.

THE Sixth International Congress for Scientific Management is to be held in London from July 15th to 20th this year under the patronage of H.R.H. the Prince of Wales and the chairmanship of Sir George Beharrell. A varied series of papers has been secured, and these will be printed and made available to members before the Congress. The necessary financial help has been given by a wide range of industrial companies, banks, commercial houses, and by professional and scientific bodies, as well as by individuals interested in particular sections of the Congress. Application for programmes and membership forms should be made to the Secretary of the Congress at 21, Tothill-street, S.W.1.

ELECTRIC inductive heating has proved particularly effective in drying articles which have been painted, lacquered, or enamelled, where quality of finish is a prime consideration. The Chrysler Corporation of America has installed inductively heated drying ovens for drying its painted and enamelled parts. The metal is heated by induction as it passes through the oven so that the volatile matter is first driven from the portions next to the metal, enabling a thicker coat of enamel to be applied for one baking. The drying time is fast and heavy parts heat relatively faster than when the heat is applied by hot air in the conventional manner. The absence of a high heat in the ovens is also claimed as a safety feature.

THE Institution of Electrical Engineers is making arrangements for a summer meeting to be held in Belgium, probably from September 8th to 14th, 1935. The programme will include excursions and visits to works, and amongst the towns included in the itinerary will be Brussels (which will probably be the headquarters town and where the Exhibition will still be in progress), Antwerp, Charleroi, Dinant, Langebrugge, Liege, Tirlemont, and also Ypres and other places in the battlefields of the Great War. Members will in due course receive details giving full information in regard to the itinerary and cost, and those who wish to take part in what should prove to be a very attractive meeting should make a special note of the date.

FOR the development of Colonial forest resources the Secretary of State for the Colonies has set up a new organisation under the Colonial Office. The organisation will be chiefly concerned with timber development, but will also interest itself in other forest products, such as wood pulp fibres, gums, and resins and the like. In both directions it will co-operate with the Imperial Institute, and will also work in close co-operation with the Forest Products Research Laboratory. The Laboratory, as a research institution, will henceforward confine itself to questions involving scientific investigation and tests, while the new organisation will take over the market promotion work, including commercial service trials, which the Laboratory formerly carried out under temporary arrangements on behalf of the Empire Marketing Board.

ACCORDING to the annual statistical summary on the British coal mining industry, issued recently by the Mines Department, the total output of saleable coal was 213,760,556 tons, and the disposable output was 198,324,915 tons. Proceeds of sales amounted to £132,685,880, averaging 13s. 4¼d. a ton, and cost of production totalled £128,557,681, averaging 12s. 11¼d. a ton, leaving a balance of £4,128,199, or 5d. a ton. Costs of production included £85,289,178 for miners' wages, £24,830,912 for management, salaries, insurances, repairs, depreciation, &c., and £14,327,950 for stores and timber. Royalties and Welfare Fund contributions made up the remainder. The number of workpeople employed was 737,960. The average earnings for a man-shift worked, including the value of allowances in kind, were just over 9s. 6d., and the average output for a man-shift just under 23 cwt.

WE have received from Ruston-Bucyrus, Ltd., Lincoln, two interesting photographs illustrating one of the company's new 10-RB ¾ cubic yard excavators equipped as a shovel at work excavating a basement beneath one of the largest department stores in Melbourne, Australia, known as Myers' Emporium. The height from the roof to the finished floor level will be 12ft. 6in. The distance between the concrete pillars in the basement is 12ft. The material which is being excavated is a fairly hard blue clay intermixed with gravel. The machine loads into 4½ cubic yard motor trucks, and the output averages 50 cubic yards of excavated material per hour, which includes the waiting time while the trucks are manœuvring into position. When the machine has completed the excavation in the basement, it will be used for digging a tunnel under a roadway separating two sections of Myers' Emporium.

Air and Water.

WITH a favourable wind, Herr R. Kronfeld flew from Bristol to London a distance of 110 miles in 1 h. 5 min. in a small aeroplane driven by a 5 h.p. motor cycle engine.

THE first of a series of night flying beacons is to be erected at Bidon Cinq in the Sahara, and eventually a series of day signs is to be laid out at intervals of 6 miles.

A DEPUTATION of the Birmingham Airport Committee of the Corporation has left by air to study a number of Continental airports. The Corporation has acquired land at Elmdon and has voted £47,000 to develop a portion of the 500-acre site as an aerodrome.

IN connection with the formal investigations which have been ordered by the Board of Trade into the losses of the steamships "Blairgowrie," "La Crescenta," "Millpool," and "Usworth," the Wreck Commissioner, Lord Merrivale, is to hold a preliminary sitting in public on May 1st.

THE harbour of Montreal is to be deepened to a depth of 35ft., and eight new piers are to be built below Saint Mary's, where large liners will dock in future. The sum of £700,000 has been allocated by the Government Public Works Bill for this work, which will increase the harbour's docking capacity by half.

REPLYING to a question in the House of Commons with regard to the fact that a German firm is to supply the plywood for the "Queen Mary," Mr. N. Chamberlain said that the lowest price quoted for the wood by a British firm was 2s. 2½d. a square foot, whilst the German price quoted was 1s. 2¾d. a square foot.

A MERGER of British air companies, resulting in air lines from the Channel Islands in the south to the Orkneys in the north being brought under one control, will receive its inception at Blackpool on April 30th. This merger will link up Blackpool, Scotland, the North-East Coast, the Midlands, the South of England, and the Isle of Man.

THE effect of smoke on aviation is to be considered by a special conference arranged by the National Smoke Abatement Society to take place in London on May 30th. The aim of the conference will be to collect evidence on the way in which the smoke of towns and industrial areas, by obscuring landmarks, reducing visibility, and promoting foggy conditions, is an impediment or danger to flying operations.

THE largest British motor coastal vessel, "Pacific Coast," was recently launched by the Ardrossan Dockyard, Ltd. She is intended for the Coast Lines' London-Liverpool service, and is a twin-screw motor ship, 250ft. long by 38ft. broad, having a depth of 22·9ft. from the upper deck. The ship is designed to carry 1600 tons deadweight on a draught of 14ft. 6in., and is propelled by two Polar Atlas engines designed to develop together 1450 b.h.p. and giving a sea speed of about 12 knots.

THE Royal Mail liner "Alcantara" has returned to Southampton from Belfast, where she has been converted from Diesel to steam propulsion by her builders, Harland and Wolff, Ltd. On her trial trips the vessel attained her designed speed of 18¾ knots with a stated fuel consumption and horse-power, and actually reached 19 knots under the conditions stipulated. During the trip to Southampton the boilers and turbines worked very satisfactorily, and the ship will re-enter the South American service on May 4th.

LEAVING Buenos Aires at 4.45 a.m. on Sunday, April 14th, the air mail of Air France arrived at Le Bourget at 11.50 a.m. on Wednesday, April 17th, having covered the distance in five hours less than the fastest west-to-east flight on this route. Six machines took part in transporting the mail, the first from Buenos Aires to Rio de Janeiro, the second to Natal, the third (the Santos Dumont seaplane) across the Atlantic to Dakar, the fourth to Casablanca, the fifth to Toulouse, and the sixth to Paris. It is claimed that this six-stage system is now working perfectly.

A NEW company is being formed under the chairmanship of Lord Runciman for the purpose of acquiring the entire fleet and other assets of the Anchor Line (Henderson Brothers), Ltd., of Glasgow. It is understood that the new company will enter into an agreement with Runciman (London), Ltd., for the management of the business for ten years. The fleet of the Anchor Line includes nine vessels, and the new company will consider the advisability of replacing some of these with new ships of less tonnage. The fleet operates between Great Britain and New York and Great Britain and Bombay.

A WIDE range of motor craft, varying from luxury cruisers to high-speed "runabouts," is being shown at the Power Boat Exhibition of the British Power Boat Company at Hythe. There are also many other interesting craft in the Exhibition, including an example of the admiral's barge that is being supplied to the Navy and one of the life-saving dinghies with which the R.A.F. is now being furnished. "Miss Britain III," with which Mr. Scott-Paine did over 111 miles an hour at Venice, is also to be seen at the show. The Exhibition will remain open untill the end of the month, when it will be followed by an exhibition of commercial craft.

IN a recent paper read before the Royal Aeronautical Society, Captain G. de Havilland said that there is a tendency to look upon metal as a more suitable material than wood, and any improvements in the strength/weight ratio of materials are to be looked for in metal. On the other hand, years of actual service under extreme climatic conditions have proved that wooden construction gives little trouble, cannot suffer from the effects of fatigue, and is cheaper to produce and repair. The "Comet" wing is an example of a new form of wooden construction, in which spruce planking is used to form a thick stressed skin which gives a very robust and durable structure and eliminates fragile sections which are liable to damage. For machines of moderate and small size, wood has been adopted primarily for reasons of cost and speed of production, and has proved safe, light, and reliable. Few will doubt, however, that metal, or possibly synthetic material, will eventually be used universally, because it is in this direction we must look for lighter construction.

capable of withstanding years of work without perceptible wear. They are interchangeable and are provided with automatic axial play compensation.

The Spindle Quill.—Is made of case-hardened steel, and is automatically cleaned by a special device located on the spindle base. Slow or rapid hand feed is obtained by operating a capstan lever or a small hand wheel provided for the purpose. The hand feed is very sensitive, owing to accurate balancing of the quill and spindle weights, a very essential condition on any machine where fine drilling or milling work has to be done.

Six automatic feed rates are available, ranging from 0·0016in. to 0·01in., up or down. There is also a depth trip provided for cutting out the automatic feed at any point desired.

One of the most interesting and novel features is the arrangement for securing and ejecting the tools from the spindle nose. This is effected by means of a patented draw-in rod device, which was especially developed, because the dimensions of the spindle are such as would not permit of easy reach to the upper end. The operation of this feature is as follows :—The spindle, when fully raised to its normal height, can be given an additional lift of about ¾in. (20 mm.), which has the effect of releasing the spindle from its driving gear, while the extremity of the tool draw-in rod is automatically locked. The necessary pull with a spanner can then be exerted for clamping or releasing the tools.

Guiding Arm for Small Drills.—The guiding arm is always supplied as an accessory with every machine. In Fig. 6 the arm is shown mounted in position on the original jig boring and drilling machine, but the arrangement is similar on the Hydroptic A. As will be seen, it is fixed on the lower part of the spindle head, and is used for small twist drills and end milling cutters of less than $\frac{1}{16}$in. (8 mm.) diameter.

The Cross Beam.—This is held by two precision elevating screws of generous dimensions and the threads are fully protected against dust or small cuttings. Its vertical motion is controlled by an electric motor, and a graduated scale is fixed to the right-hand upright to indicate its vertical position. A new and patented locking device is incorporated in the design, and is actuated by a single lever from the operator's working position. The value of this locking device is that it ensures a powerful and well-distributed clamping action at both ends of the cross beam, and at two points on each upright. The total clamping pressure is eight tons, there being three tons on each of the top positions and one ton on each of the bottom positions. The tightening of the clamping lever automatically cuts out the electric power drive, and provides a sure protection against faulty operation. A further safeguard is introduced in the form of automatic stops, which cut out the drive at each end of the vertical traverse, thus eliminating all danger of overrunning.

The optical equipment for measuring the transverse travel of the spindle head on the cross beam is similar in all respects to the table device already described. All the essential parts are indicated by Fig. 9. The spindle saddle is traversed by a patented combination. There is a rapid hand motion through a coarse-pitch screw with hand wheel, a slow hand motion by means of a knob, and an electric power drive for milling operations. The advantage of this arrangement is that all three drives remain virtually in mesh, and that the rapid hand motion can always be imposed on both the other drives by merely operating a knob, without the necessity of disconnecting them. This feature is very useful when milling work that has intermittent facings, the spaces between the facings can be quickly spanned by the use of the rapid hand traverse—that is, merely operating the hand wheel—and then allowing the electric drive to take control again, which it does immediately the operator releases the hand wheel.

Lubrication.—This important matter has received the attention it merits. All the sliding surfaces of the cross beam are provided with central lubricating facilities, which can be readily attended to.

The speed gear-box is mounted on the upright on the left-hand side. Power to it is transmitted from the main motor by means of a triple "Texrope" belt driving through a friction clutch. All the controls are localised and placed within easy reach of the operator.

In appearance the machine is robust, the general design indicating strength and rigidity, as will be seen in Figs. 7 and 8. The general overall dimensions are as follows :—Table, 39½in. by 27½in.; travel, 37½in.; maximum height of nose from face of table, 27⅝in.; travel of head on cross bar, 24in.; total length of machine, 108in.; width, 92½in.; height, 104½in.

Altogether, the machine is a fine example of the machine maker's art. To produce a machine capable of measuring with the accuracy of a scientific instrument, to make that accuracy permanent, and at the same time combine it with a high production unit, is a great achievement.

ANSWERING a question addressed to him on April 9th, Mr. Hore-Belisha said that the number of persons killed in road accidents in Great Britain per 100,000 of the total population was 15·9 in 1933 and 16·2 in 1934.

Train Ferry Steamers for the S.R.*

By Sir WESTCOTT ABELL.

VARIOUS forms of vessels to carry trains are not uncommon, but generally they are used on lakes and inland seas with limited regions of operation. The vessels recently built for the Southern Railway to carry passenger and goods trains from Dover to the French Channel ports have this distinction, that they have to operate on services where they are exposed to full sea-going conditions.

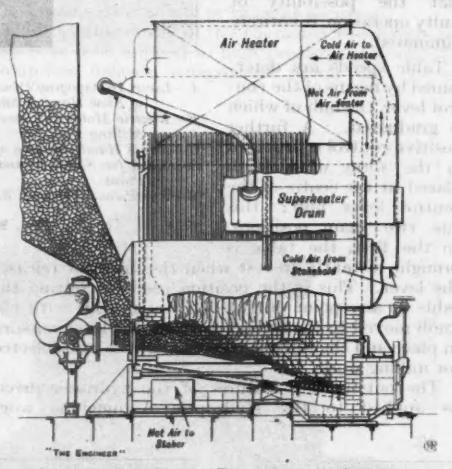
The restrictions imposed by the service on the vessels' dimensions were considerable. The length was limited to 360ft. overall, the maximum breadth over fenders to 63ft., and the draught of water to 12ft. 6in., ordinary loading. As a further restriction the height of the train deck above water was 7ft. 6in. from the ordinary load line, and thus the moulded depth was only 20ft. A speed of 16½ knots was required, and a coal consumption trial of six hours at that speed had to be carried out. In addition, the engines were required to be capable of obtaining revolutions astern which were 85 per cent. of those corresponding to 16½ knots ahead, which revolutions were limited to 200.

The train decks had to accommodate twelve sleeping cars and two baggage wagons, or alternatively forty 25ft. goods wagons on four sets of rails. Two platforms were required, one on each side of the ship, between each pair of tracks, so that passengers could alight and have access to the accommodation on the deck above the trains. The necessary access to the machinery spaces had to pass through these platforms.

The maximum deadweight to be carried, apart from the weights necessary for the operation of the ship in average conditions, was 1200 tons.

The question of loading and discharging the trains from the ship required consideration, having in view the difference in tide level at Dover, which might vary as much as 20ft., and the fact that Dover Harbour is subject to swells of appreciable magnitude in certain conditions (a swell of 6ft. height has been measured).

Under these circumstances it was decided that an



ARRANGEMENT OF BOILER AND STOKER

impounding lock must be used to berth the ship, the water level being adjusted to a constant height. With this provision, seeing that the vessel should berth stern first, it was necessary for her to turn inside the harbour and proceed astern into the lock, and every precaution was taken to ensure that vibration when going astern should as far as possible be removed.

After discussion with the Board of Trade, it was agreed that the subdivision requirements should be equivalent to the two-compartment standard—that is, the vessel should be capable of remaining afloat with any main transverse bulkhead carried away, or with the equivalent thereof.

A number of alternative propulsive arrangements were examined, including steam reciprocators and geared turbines with Scotch and water-tube boilers using both coal and oil as fuel, and with automatic stokers with the turbines having both geared and electric drives, while proposals to use Diesel engines both with direct and with electric drives were also considered. At least twelve different types of propulsion were investigated, and even this number did not include two further economies which might prove useful for a steam drive.

The voyage is a short one, the amount of fuel to be carried is relatively small, and consequently the variation in choice of machinery did not appreciably affect the cost of the hull and equipment. The choice of the most suitable type was principally governed by the following considerations :—(i) The weight of machinery, (ii) the first cost, and (iii) the cost of operation.

It was clear that a steam reciprocator, whether with coal or oil as fuel, was for other reasons not generally suitable. It was clear also that with water-tube boilers fitted with heat economisers and automatic stokers the fuel costs were less with coal, than with oil. The final selection lay between :—

(*a*) Steam turbines and water-tube boilers, using coal as fuel with automatic stokers and with mechanical gear in preference to electric drive ; and

(*b*) Oil engines (direct driven Diesels).

Here it may be stated that owing to the peculiar type of ship it is possible to run a train of coal trucks direct on board, say, once a week, and by lifting parts of the platform to discharge the coal by tipping into the bunkers, which were designed so that the coal is fed by gravity direct into the hoppers of the automatic stokers, resulting in considerable savings in handling.

Moreover, the cost of coal for use with automatic stokers is comparatively low, and thus compares more than favourably with the price of oil fuel.

It must also be remembered that absence of vibration, noiseless running, and power going astern were important factors to be considered, while reliability in operation and maintenance of machinery in service are weighty factors for railway traffic.

The choice, therefore, of a steam drive with single-reduction turbines and with water-tube boilers with automatic stokers and automatic bunkering, was justified on all counts.

In the interest of coal economy it was decided, further, to fit the water-tube boilers with air heaters and to use the closed stokehold system. It may be observed, however, that only a moderate degree of superheat was provided, principally because it was desired to make the propulsion system as simple as possible.

Notwithstanding the lack of head-room, the lay-out of the machinery is simple and straightforward. It is possible for the engineer in charge to control both turbines from the same position and to see readily the performance and working of the necessary auxiliaries. The boiler-room is also simply disposed, so that the man in charge can see from one position the performance of each boiler. The advantage of the longitudinal wing subdivision is thus apparent.

Acting on the suggestion of Mr. McQueen, the marine engineer of the Southern Railway at Dover, the control arrangements of the two turbines were arranged so that they can be individually operated by one man from one position, at which the working of the main auxiliaries is readily seen.

MACHINERY.

The propelling machinery consists of two sets of single-reduction turbines operating twin screws, each set being designed for 2500 s.h.p. and being capable of an overload of 20 per cent.

There are high and low-pressure turbines both ahead and astern, and these drive a single gear wheel with a reduction speed ratio of 17·56 to 1, the turbine revolutions at full power being 3550 per minute.

The main condensers are underslung below the low-pressure cylinder casing. They are of the regenerative type, designed to maintain a vacuum of 28½in. with the barometer at 30in. and with a sea water temperature of 65 deg. Fah.

Steam is generated by four Yarrow boilers of the latest type, having large steam and water drums with straight tubes, ensuring good circulation and easy inspection and cleaning. A very large proportion of the heating surface is exposed to direct radiant heat, and the furnace is of sufficient capacity to ensure complete combustion. There is a small superheater designed to give 100 deg. Fah. superheat, recessed on one side of the tube space. On the upper part of the boiler there is a large air heater of the horizontal type, through which the air passes from the stokehold round the boilers to the underside of the mechanical stoker. Each boiler unit is designed to evaporate 16,000 lb. steam per hour (with an overload of 20 per cent.) at a working pressure of 250 lb. per square inch and a total steam temperature of about 500 deg. Fah. with a feed water temperature of 270 deg. Fah. The air heater is designed to supply the air below the stokers at a temperature of between 350 deg. and 400 deg. Fah.

The closed stokehold system is used, the air being supplied direct to the stokehold by two forced draught fans which can work up to a pressure of 6in.

The mechanical stokers were made by the Taylor Stoker Company, and the bunkers are so arranged as to be self-trimming ; the coal, fed by gravity to the hoppers of the stoker, is pushed on to the grate by the operation of the feeding rams and is traversed by the reciprocating parts of the grate, the only manual labour required being the removal of the ash from the special ashpits. In operation this grate produces a layer of incandescent coke which practically covers the main surface of the grate, giving a short flame combustion and a homogeneous fuel bed, with the result that the greater part of the heat transmission is by radiation.

The stokers are motor driven through a chain of reduction gearing, and the combustion is easily controlled by means of air supply and the revolutions of the stoker.

The auxiliary machinery is steam driven throughout the ship, and special arrangements are made to ensure economy in the auxiliary service.

The installation of machinery and the general arrangements of the machinery and auxiliaries was carried out by Swan, Hunter and Wigham Richardson, Ltd.

* Institution of Naval Architects, April 11th, 1935. Abridged.

ALUMINIUM MIRRORS.

IN the issue of THE METALLURGIST which is presented with this copy of THE ENGINEER, there will be found an article on the production of high-class optical mirrors by what is known as the evaporation process. This process consists in heating a selected metal to its evaporation temperature, in vacuo, and causing it to condense upon the surface which it is desired to treat. Aluminium has proved to be an admirable metal for the production of mirrors and the results attained are astonishing. The surface is not only highly reflective, but it tarnishes very slowly and can be cleaned by the application of pure soap and water. Hence, the actual surface itself may be used in astronomical telescopes and for similar purposes. The technology of the process has been carried to such a degree of perfection that a telescope mirror 100in. in diameter has recently been produced in America. Now that the workshop problems have been solved, it seems extremely probable that the coating of surfaces by the evaporation process for protection, or ornamentation, or specific scientific purposes, may become a quite important industry.

AN order has been placed in Canada for what are probably the three largest wooden storage tanks of their kind. They comprise three closely grouped ground wood storage and blending tanks, 34ft. in diameter and 56ft. high, and on account of their unusual height will require some 78 tons of steel bands. The estimated cost of these tanks is 75,000 dollars.

Rail and Road.

ACCORDING to the monthly progress report of the Society of Motor Manufacturers and Traders, there are at present 2,012,714 vehicles in use in this country, as against 1,789,336 a year ago.

WE have reason to believe that the Southern Railway electrical services to Eastbourne, Hastings, and Seaford will be opened, with the summer train services, on July 7th. The journey time from London to Hastings will be reduced by seventeen minutes, and the number of trains increased by twenty-five a day.

WHEN the Minister of Transport opened the Lockwith Viaduct at Cardiff recently, he said that there are fifty-four toll roads and seventy-two toll bridges still remaining in private ownership in this country, and to encourage their removal, wherever the public convenience can be assisted, he is willing to make grants from the Road Fund.

THE April issue of the *Railway Magazine* gives the interesting information that the Great Western Railway, in its 261 miles between Paddington and Fishguard, cuts across the boundary line of eleven counties no fewer than twenty-one times. There are eleven crossings of the Carmarthenshire-Pembrokeshire boundary in 6 miles, and two of these are within 10 yards of each other. Clynderwen station is at this point, and the waiting-room is on the dividing line, so that part of the building is in one county and part in another.

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THE death, on April 13th, of Sir William Marwood, removed a man of unusually charming personality. While the last four years of his official career were spent in the Ministry of Transport after its formation in 1919, and where he was Director-General of Public Services and General Purposes, his work at the Board of Trade, as Secretary of the Railway Department, was the activity by which he was best known. He there most ably performed those duties which it was considered to be the responsibility of the Board of Trade; that is, to act, without bias towards either side, as intermediary between the railway companies on the one hand and traders and the public on the other.

THE recent closing down as an hotel, and its new use as offices for the railway company, of the Midland Grand Hotel, St. Pancras, may be said to have been anticipated two years ago. In March, 1933, Sir Josiah Stamp, the L.M.S. president, speaking at the annual dinner of the Royal Institution of British Architects, said, of the Great Hall at Euston, which was designed by Hardwick, that with the pressure of economic stress its glory had lately departed. Sir Josiah added that he was troubled about the St. Pancras Hotel, a building that was obsolete as an hotel and useless for offices. It was designed by Sir Gilbert Scott, grandfather of Sir Giles Scott, the architect of Liverpool Cathedral, during an enforced stay in London through the "dead" season, owing to the illness of a member of his family. St. Pancras Station was opened on October 1st, 1868.

FROM time to time references are made to track circuit as a safeguard against railway collisions. This is a very simple arrangement, the basis of which is a primary battery, at the outgoing end of the track circuited section, which is joined to one of the running rails of the section. The contiguous rails are bonded together by a light wire and current from the battery flows through the rails to a relay at the ingoing end of the section. The relay, in turn, holds a lock on the lever of the signal for entering the section, and the current returns to the battery by the other rail. The presence of a vehicle in the section short circuits the current by means of the wheels and axles, and the relay, which has allowed the lever to be free, is de-energised and the lever is held so that no train may enter the occupied section. It will be obvious that sand on the rail might prevent the vehicle short circuiting the current, and that always has been a difficulty. It is satisfactory, therefore, to report that the twenty new tank engines of the L.M.S., mentioned herein on March 15th, have a de-sanding arrangement whereby the sand applied in front of the wheels is washed off the rail after the wheels have passed over the sand.

THE Minister of Transport, when, on April 11th, he unveiled the model of the "Rocket" at the Science Museum, was over sanguine when he suggested that the death of Mr. Huskisson at the opening of the Liverpool and Manchester Railway on September 15th, 1830, "had perhaps stimulated Parliament to provide that the new form of transport should be accompanied at every stage by adequate precautions for the public safety." Mr. Huskisson was killed by, to use the phrase of the modern accidents reports, his own want of care, in that he crossed, from the side of the line, over what is now the down line, to shake hands with the Duke of Wellington who was in the special on the up line. When standing at the door of the carriage he was foul of the down line on which the "Rocket" was approaching. The latter engine struck the carriage door and Mr. Huskisson was thrown on to the down line and run over, receiving such injuries that he died a few hours later. Not for another ten years were any steps taken to secure "adequate protection for the public safety." Following a recommendation by the Select Committee of 1839 on Railway Communication the Regulation of Railways Act of 1840—3 and 4 Vic. c 97—called for returns of railway traffic, "as well as of all accidents which shall have occurred thereon attended with personal injury." It may be added that the "six foot" between the two running lines was one of only 4ft.; that the special carriage projected 2ft. into this space, and the carriage door overlapped the down line by 6in.

Miscellanea.

THE Hetch Hetchy Dam, which was described in THE ENGINEER of April 6th, 1934, is 344·5ft. from the lowest point of its foundation to its crest, and plans have been approved by the United States Secretary of the Interior to heighten it to 429·5ft. The additional 85ft. will increase storage capacity 69 per cent.

TWO technological representatives of the Provincial Government of Shansi, China's coal area, were taken over the low-temperature carbonisation plant at Askern, near Doncaster, and Barugh, Barnsley, to inspect the processes in operation, with a view to an installation of their own. The Shansi Government wishes to have locally produced supplies of fuel for motor vehicles, heavy oil engines, and lubrication, and is considering the possibilities of setting up a plant treating between 150 and 200 tons of coal a day.

AS a permanent memorial to the King's Jubilee, the United Steel Companies, Ltd., after consultation with representatives of the works councils of the various branch companies, and with their full agreement, decided that in lieu of any holiday or holiday payments there should be established convalescent and holiday homes for employees and/or cottage homes for retired employees. The money available for the purpose will be at least £10,000, and may exceed this sum. The final details of the scheme have yet to be decided and approved by the board, and the final decision will be taken early in May.

THE Sixth International Congress for Scientific Management is to be held in London from July 15th to 20th this year under the patronage of H.R.H. the Prince of Wales and the chairmanship of Sir George Beharrell. A varied series of papers has been secured, and these will be printed and made available to members before the Congress. The necessary financial help has been given by a wide range of industrial companies, banks, commercial houses, and by professional and scientific bodies, as well as by individuals interested in particular sections of the Congress. Application for programmes and membership forms should be made to the Secretary of the Congress at 21, Tothill-street, S.W.1.

ELECTRIC inductive heating has proved particularly effective in drying articles which have been painted, lacquered, or enamelled, where quality of finish is a prime consideration. The Chrysler Corporation of America has installed inductively heated drying ovens for drying its painted and enamelled parts. The metal is heated by induction as it passes through the oven so that the volatile matter is first driven from the portions next to the metal, enabling a thicker coat of enamel to be applied for one baking. The drying time is fast and heavy parts heat relatively faster than when the heat is applied by hot air in the conventional manner. The absence of a high heat in the ovens is also claimed as a safety feature.

THE Institution of Electrical Engineers is making arrangements for a summer meeting to be held in Belgium, probably from September 8th to 14th, 1935. The programme will include excursions and visits to works, and amongst the towns included in the itinerary will be Brussels (which will probably be the headquarters town and where the Exhibition will still be in progress), Antwerp, Charleroi, Dinant, Langebrugge, Liege, Tirlemont, and also Ypres and other places in the battlefields of the Great War. Members will in due course receive details giving full information in regard to the itinerary and cost, and those who wish to take part in what should prove to be a very attractive meeting should make a special note of the date.

FOR the development of Colonial forest resources the Secretary of State for the Colonies has set up a new organisation under the Colonial Office. The organisation will be chiefly concerned with timber development, but will also interest itself in other forest products, such as wood pulp fibres, gums, and resins and the like. In both directions it will co-operate with the Imperial Institute, and will also work in close co-operation with the Forest Products Research Laboratory. The Laboratory, as a research institution, will henceforward confine itself to questions involving scientific investigation and tests, while the new organisation will take over the market promotion work, including commercial service trials, which the Laboratory formerly carried out under temporary arrangements on behalf of the Empire Marketing Board.

ACCORDING to the annual statistical summary on the British coal mining industry, issued recently by the Mines Department, the total output of saleable coal was 213,760,556 tons, and the disposable output was 198,324,915 tons. Proceeds of sales amounted to £132,685,880, averaging 13s. 4¼d. a ton, and cost of production totalled £128,557,681, averaging 12s. 11¼d. a ton, leaving a balance of £4,128,199, or 5d. a ton. Costs of production included £85,289,178 for miners' wages, £24,830,912 for management, salaries, insurances, repairs, depreciation, &c., and £14,327,950 for stores and timber. Royalties and Welfare Fund contributions made up the remainder. The number of workpeople employed was 737,960. The average earnings for a man-shift worked, including the value of allowances in kind, were just over 9s. 6d., and the average output for a man-shift just under 23 cwt.

WE have received from Ruston-Bucyrus, Ltd., Lincoln, two interesting photographs illustrating one of the company's new 10-RB ¾ cubic yard excavators equipped as a shovel at work excavating a basement beneath one of the largest department stores in Melbourne, Australia, known as Myers' Emporium. The height from the roof to the finished floor level will be 12ft. 6in. The distance between the concrete pillars in the basement is 12ft. The material which is being excavated is a fairly hard blue clay intermixed with gravel. The machine loads into 4½ cubic yard motor trucks, and the output averages 50 cubic yards of excavated material per hour, which includes the waiting time while the trucks are manœuvring into position. When the machine has completed the excavation in the basement, it will be used for digging a tunnel under a roadway separating two sections of Myers' Emporium.

Air and Water.

WITH a favourable wind, Herr R. Kronfeld flew from Bristol to London a distance of 110 miles in 1 h. 5 min. in a small aeroplane driven by a 5 h.p. motor cycle engine.

THE first of a series of night flying beacons is to be erected at Bidon Cinq in the Sahara, and eventually a series of day signs is to be laid out at intervals of 6 miles.

A DEPUTATION of the Birmingham Airport Committee of the Corporation has left by air to study a number of Continental airports. The Corporation has acquired land at Elmdon and has voted £47,000 to develop a portion of the 500-acre site as an aerodrome.

IN connection with the formal investigations which have been ordered by the Board of Trade into the losses of the steamships "Blairgowrie," "La Crescenta," "Millpool," and "Usworth," the Wreck Commissioner, Lord Merrivale, is to hold a preliminary sitting in public on May 1st.

THE harbour of Montreal is to be deepened to a depth of 35ft., and eight new piers are to be built below Saint Mary's, where large liners will dock in future. The sum of £700,000 has been allocated by the Government Public Works Bill for this work, which will increase the harbour's docking capacity by half.

REPLYING to a question in the House of Commons with regard to the fact that a German firm is to supply the plywood for the "Queen Mary," Mr. N. Chamberlain said that the lowest price quoted for the wood by a British firm was 2s. 2½d. a square foot, whilst the German price quoted was 1s. 2½d. a square foot.

A MERGER of British air companies, resulting in air lines from the Channel Islands in the south to the Orkneys in the north being brought under one control, will receive its inception at Blackpool on April 30th. This merger will link up Blackpool, Scotland, the North-East Coast, the Midlands, the South of England, and the Isle of Man.

THE effect of smoke on aviation is to be considered by a special conference arranged by the National Smoke Abatement Society to take place in London on May 30th. The aim of the conference will be to collect evidence on the way in which the smoke of towns and industrial areas, by obscuring landmarks, reducing visibility, and promoting foggy conditions, is an impediment or danger to flying operations.

THE largest British motor coastal vessel, "Pacific Coast," was recently launched by the Ardrossan Dockyard, Ltd. She is intended for the Coast Lines' London-Liverpool service, and is a twin-screw motor ship, 250ft. long by 38ft. broad, having a depth of 22·9ft. from the upper deck. The ship is designed to carry 1600 tons deadweight on a draught of 14ft. 6in., and is propelled by two Polar Atlas engines designed to develop together 1450 b.h.p. and giving a sea speed of about 12 knots.

THE Royal Mail liner "Alcantara" has returned to Southampton from Belfast, where she has been converted from Diesel to steam propulsion by her builders, Harland and Wolff, Ltd. On her trial trips the vessel attained her designed speed of 18¾ knots with a stated fuel consumption and horse-power, and actually reached 19 knots under the conditions stipulated. During the trip to Southampton the boilers and turbines worked very satisfactorily, and the ship will re-enter the South American service on May 4th.

LEAVING Buenos Aires at 4.45 a.m. on Sunday, April 14th, the air mail of Air France arrived at Le Bourget at 11.50 a.m. on Wednesday, April 17th, having covered the distance in five hours less than the fastest west-to-east flight on this route. Six machines took part in transporting the mail, the first from Buenos Aires to Rio de Janeiro, the second to Natal, the third (the Santos Dumont seaplane) across the Atlantic to Dakar, the fourth to Casablanca, the fifth to Toulouse, and the sixth to Paris. It is claimed that this six-stage system is now working perfectly.

A NEW company is being formed under the chairmanship of Lord Runciman for the purpose of acquiring the entire fleet and other assets of the Anchor Line (Henderson Brothers), Ltd., of Glasgow. It is understood that the new company will enter into an agreement with Runciman (London), Ltd., for the management of the business for ten years. The fleet of the Anchor Line includes nine vessels, and the new company will consider the advisability of replacing some of these with new ships of less tonnage. The fleet operates between Great Britain and New York and Great Britain and Bombay.

A WIDE range of motor craft, varying from luxury cruisers to high-speed "runabouts," is being shown at the Power Boat Exhibition of the British Power Boat Company at Hythe. There are also many other interesting craft in the Exhibition, including an example of the admiral's barge that is being supplied to the Navy and one of the life-saving dinghies with which the R.A.F. is now being furnished. "Miss Britain III," with which Mr. Scott-Paine did over 111 miles an hour at Venice, is also to be seen at the show. The Exhibition will remain open untill the end of the month, when it will be followed by an exhibition of commercial craft.

IN a recent paper read before the Royal Aeronautical Society, Captain G. de Havilland said that there is a tendency to look upon metal as a more suitable material than wood, and any improvements in the strength/weight ratio of materials are to be looked for in metal. On the other hand, years of actual service under extreme climatic conditions have proved that wooden construction gives little trouble, cannot suffer from the effects of fatigue, and is cheaper to produce and repair. The "Comet" wing is an example of a new form of wooden construction, in which spruce planking is used to form a thick stressed skin which gives a very robust and durable structure and eliminates fragile sections which are liable to damage. For machines of moderate and small size, wood has been adopted primarily for reasons of cost and speed of production, and has proved safe, light, and reliable. Few will doubt, however, that metal, or possibly synthetic material, will eventually be used universally, because it is in this direction we must look for lighter construction.

CRAIGAVON DOUBLE-DECK BRIDGE, LONDONDERRY

MESSRS. MOTT, HAY AND ANDERSON, WESTMINSTER, ENGINEERS

(*For description see page 428.*)

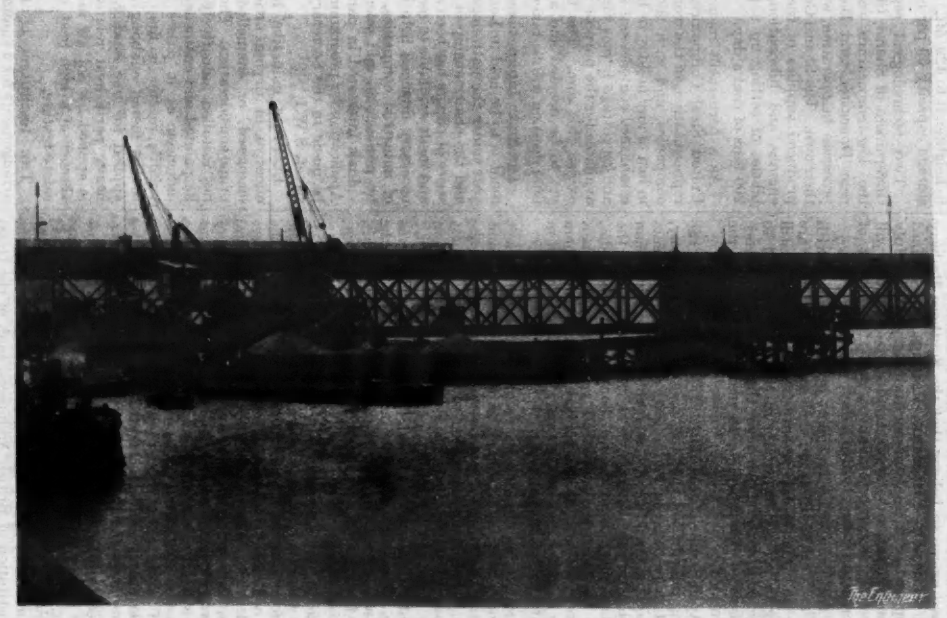

FIG. 4 (ABOVE):—VIEW OF CARLISLE BRIDGE IN 1921

FIG. 5 (BELOW):—VIEW OF CRAIGAVON BRIDGE IN SEPTEMBER, 1934

FIG. 6 (ABOVE):—LOWER DECK OF CRAIGAVON BRIDGE—SEPTEMBER, 1934

FIG. 7 (BELOW):—CYLINDERS READY FOR LAUNCHING—SEPTEMBER, 1931

The Engineer

APRIL 26, 1935.

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

NOTICES TO READERS.

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The Metallurgist.

THE APRIL NUMBER OF
THE METALLURGICAL SUPPLEMENT TO
"THE ENGINEER" ACCOMPANIES THIS ISSUE.

TEAM WORK.

IN his charming little book about the lion-cub "Engato," Dr. J. H. Driberg describes an elephant hunt in which he took part with the Lango. The huntsmen of the Lango are all expert spear throwers and they depend upon this weapon alone when engaged in the chase. A small herd of elephants having been located a large party of beaters is sent out to get behind it and drive the beasts towards a row of huntsmen. Only one elephant is selected for destruction; the others are allowed to pass through the line. The huntsman towards whom the doomed animal is galloping flings his spear and must then stand fast. Before the wounded animal can reach him the spearman on the attacker's right casts his spear, and the elephant immediately rushes towards his new assailant, who, in his turn, is saved by his neighbour. Thus the beast is driven along the line until, sorely wounded, it is allowed to pass through, to be followed leisurely by the whole hunt. It would be difficult to find a more striking example of team work, for the success depends upon each man standing firm and having complete confidence in the skill and alertness of his neighbour. If one fails, he not only imperils the life of his fellow, but the elephant breaks through and escapes. Thus we see perfect team work combined with perfect individualism—a combination devoutly to be wished.

This sporting example came to our minds as we read the appeal, printed in our issue of April 12th, of the British Cast Iron Research Association and, in the same hour, Professor Thorpe's presidential address, published in Part II of the 1935 "Proceedings" of the Institute of Chemistry. For whereas the appeal is for what may be very roughly described as impersonal research, Professor Thorpe stressed the value of individualism and quoted with approval from General Smuts' famous Rectorial Address to the University of St. Andrews the words: "The disappearance of the sturdy, independent-minded, freedom-loving individual and his replacement by a servile standardisation mass-mentality is the greatest menace of our time." Opposed as these views may appear at first sight, we have not the slightest doubt that each party would heartily endorse the opinions of the other—Professor Thorpe commending the work of the British Cast Iron Research Association, and Mr. Pearce approving the principles of individualism. Speaking at the last luncheon of the Association, Major Freeth, the President, emitting one of those brilliant sparks which illuminate his addresses, warned the members of the Association against regarding their research association as a "psychological plaster." He asked them not to turn to the Association whenever they found themselves in a little difficulty, but first of all to exercise their own intelligence upon the solution. The advice was necessary. There is always a danger when an organisation is set up for a particular function that people will turn to it and discharge themselves of all responsibility for taking thought. Sometimes that is probably desirable; there are cases which it is best to leave entirely to the specialist. Stroudley used to hold that the best express drivers were those who knew least about the mechanism of their engines. Lack of knowledge in such cases induces peace of mind; a little knowledge provokes constant anxiety. Furthermore, in research work many problems can only be adequately attacked by united action, and the richer and more powerful the research association the better is it able to bring forces to bear for the general good. The science of cast iron has been enormously increased by its research association, and, apart altogether from the lure that is held out in the form of increased Government grant, the industry should support that Association on account of the benefit which it secures from the best kind of work undertaken by it.

But there is another aspect of the services of research associations which, we submit, ought to be more widely recognised. Whilst it cannot be denied that all progress is of national importance, it is manifest that some problems are more properly suited for national research than others. In the case of any research association which is receiving the equal of its own contributions from the Government, it may be said that half the expense of any research undertaken for the industry is borne by the public. But since the industry is the main and primary beneficiary, it is, we suggest, improper, in many cases, for any such tax to be laid upon the public; the industry should undertake its own research, at its own expense for its own benefit. That is where Professor Thorpe's "individualism" comes in again. The object to be aimed at, the object which exhibits the perfection of team work without the removal of individualism, would be the complete removal of Government grants and the support of all research associations by the industries themselves. We believe that that ideal condition has always been visualised by the Privy Council, but it is very often forgotten. Many firms which could quite well possess their own research laboratories neglect to do so and send all their problems to their Association. In view of the smallness of their individual subscriptions, much of the service they receive is paid for out of public revenues. We are fully aware that some research associations could not be carried on at all if it were not for the attraction offered by services of this order, but we do think it ought to be frequently impressed upon members that, save when a special fee is paid, they should endeavour to solve their own problems by their own efforts.

Electrical Development.

AT the National Electrical Convention Press luncheon, held at the Savoy Hotel, London, on Tuesday, April 16th, Viscount Elibank explained that the Convention, which is to be held at Bournemouth from June 3rd to 8th, will be the first of its kind. Representatives from every section of the electrical industry, ranging from manufacturers and supply engineers to salesmen, will be present. Although only two papers, one on "Industrial Supply" and the other on "Domestic Electrical Development," are to be read, this large and important gathering is expected to do an immense amount of good. We wish the Convention every success. Great efforts are to be made to mark this Jubilee year by inaugurating a movement of progress, rationalisation, and rehabilitation, which will reach every home and factory throughout the country. As Viscount Elibank remarked, no one wants the grid to become an obstruction to traffic like, say, the statue of Sir Robert Peel. Whatever opinions may be held concerning the national scheme, there is no denying the fact that without electricity no country can hold its own in the industrial world. But, as Mr. E. E. Hoadley, the President, pointed out in a subsequent speech, if cheap electricity is to be provided universally throughout the country in the near future, many problems call for early attention. Some are technical and a few political, but most of them are financial. Those concerning the standardisation of pressure and methods of charging for electricity are pressing, for there is no one who is not interested in securing current at standard voltage and at the lowest rate. An Exhibition to be held in conjunction with the Convention will be the largest of its kind. It will include sections devoted to electro-medical science, domestic appliances, horticultural plant, and public lighting equipment, and there will be specimens of the latest electric vehicles.

So far as can be judged from the speeches mentioned, every effort is being exerted to make the Convention a success. Its main object, it seems, is to make the people of this country electrically minded, but it is to be hoped that it will also tend to promote harmony among all who are engaged in the important business of providing electricity supplies. No useful purpose can be served by trying to disguise the fact that the industry is at present lacking the necessary co-operative spirit. In the days of individualistic operation, engineers at the head of electricity supply systems had little opportunity for blaming other people for unsatisfactory results. If their undertakings did not pay, they alone were generally held responsible. With the advent of the grid, however, the industry was split into two camps. One (the grid) is called "socialistic," and the other, composed of the undertakings, is to some extent capitalistic. Thus it is not surprising that a certain amount of discord exists. Undertakings with selected stations are complaining that they are not getting a square deal. Some contend, and apparently not without justification, that they are supplying the grid at an unsatisfactory price, and that they could get along much better under the old scheme. Supporters of the grid, on the other hand, assert that the distributing undertakings are failing to give the Board the support it needs to meet the estimates set forth in the supplementary particulars relating to the various electricity schemes. Many homes, they explain, are still without the long-promised cheap and abundant supply, but people seem to forget that it was not the undertakings that promised that supply. The politicians who told the public that they might expect an abundance of cheap electricity appear to have imagined that all that was necessary to secure the desired result was to shut down old and inefficient stations and to interconnect the remaining stations. Saving in coal was the main thing to be aimed at. But it has now apparently become obvious to the most optimistic of those gentlemen that ways and means must be found for getting the cheap electricity to the millions of potential consumers. Control of distribution is therefore being sought, and to show how essential that control is, it is sufficient to observe that company undertakings are alleged to be indifferent to everything save profits. The results achieved by private enterprise are, in the eyes of the grid supporters, apparently not worth considering when compared with what might be secured under a properly organised national distribution scheme. But it is well within the range of possibility that those who have spent a large part of their lives in building up the more important undertakings know what areas can be profitably developed better than anyone can tell them. Large sums of money spent on distribution schemes for sparsely populated parts will not necessarily bring cheap electricity to the consumers concerned. All the talk about the great advantages of electricity will not wipe out distribution costs, although it must, of course, be admitted that intensive propaganda is essential in the interests of the industry as a whole. But what sort of encouragement is the Board giving to owners of certain selected stations to spend money on new distribution schemes of doubtful commercial value? While some of these undertakers appear to be more or less satisfied with the price they are being paid for exported energy, others maintain that they are supplying the grid at a loss. Their plant, which, in the absence of the grid, might be utilised to good advantage, is being loaded by the Board without recognition of the capital costs. Dissatisfaction therefore exists, and the industry is suffering in consequence.

The Bournemouth Convention would indeed be a wonderful affair if it led to the solution of all the

problems with which the industry is faced. It is to be, hoped, however, that the bringing together of so many able men will lead to something more than merely making the people of this country realise more fully the advantages of electricity. May it also be the means of causing those who are inclined to stir up strife and attribute all shortcomings to private enterprise or to the defects of the grid, recognise that such activities are liable to retard rather than further progress. Even if it were universally agreed that the grid is an utter failure, it could scarcely be scrapped. Ways and means must be found of overcoming its defects and of satisfying, as far as possible, those who maintain that they would be better off without it. Similarly, if there is any real lack of initiative on the part of the undertakings, they must be brought to mend their ways. Let it be remembered that the average consumer knows little and cares less about the inner workings of the electricity supply industry, and the only conclusion he is likely to draw from the continual bickering is that, unlike those who supply gas, providers of electricity are very quarrelsome people.

Engineers and the New Arbitration Act.

By W. SUMMERFIELD, M.A., B.C.L., LL.B., Barrister-at-Law.
Author of "The Law of Arbitration and Awards."

ENGINEERS are very intimately concerned with arbitration law and practice, and any steps which may be taken to improve the facilities offered by arbitration tribunals. Few go through their professional career without being called upon to submit a dispute to an arbitrator, or to give evidence as an expert before such a lay judge or even themselves to act in such a capacity. Whatever may be urged against the system by the opponents of arbitration, certain it is that in resolving the technical problems arising in and from the practice of engineering, it has abundantly proved its utility as a practical and effective substitute to litigation. The reforms introduced by the Arbitration Act, 1934, which took effect as from January 1st of this year, mark a very great advance. All of them are of general interest to the engineer, whilst some of the more important are of direct and special interest to him.

The Act provides that the Arbitration Act, 1889, the Arbitration Clauses (Protocol) Act, 1924, and the Arbitration (Foreign Awards) Act, 1930, are to be "construed as one" with the Arbitration Act, 1934, so that we now have a comprehensive code of arbitration law covering cases which may arise within these isles and also such as involve dealings overseas. Firms supplying machinery or materials generally, with or without construction services, will welcome the new provisions whereby the status of an award is enhanced. Under Sec. 12 of the 1889 Act, it was provided that "an award on a submission may, by leave of the Court or a Judge, be enforced in the same manner as a judgment or order to the same effect." Sec. 10 of the new Act provides that where such leave is given, "judgment may be entered in terms of the award." Thus, a liability imposed upon a disputant by an arbitrator's award enjoys the status of a judgment debt, so that a bankruptcy notice may be founded upon the award if the liability is not discharged; and, furthermore, if the party so rendered liable is resident abroad or owns property overseas, the aid of the foreign courts to enforce the terms of the award becomes much more readily available, since foreign courts recognise judgments of the English courts and lend the weight of their authority to secure their local enforcement with a speed and respect which has not always been accorded hitherto to the awards of lay tribunals.

Wider Powers.

The Act of 1889 contains, in the First Schedule, nine sets of provisions which impliedly govern all submissions to arbitration, *i.e.*, apply to the proceedings unless the disputants expressly contract out of them by the terms of their submission. To these have now been added two extremely important provisions, widening the scope of awards and expediting the remedies sought to be obtained from them. First, it is enacted that "the arbitrators or umpire shall have the same power as the court to order specific performance of any contract," the only exception being a contract which "relates to land or any interest in land." Here, again, the powers of the arbitrator are approximated to those of a Judge, and a particularly interesting matter in connection with which they may fall to be exercised is where a claim arises for breach of contract to deliver specific or ascertained goods, materials, or machinery; for the arbitrator, following the rule contained in Sec. 52 of the Sale of Goods Act, 1893, may henceforth award that the contract be performed specifically without giving to the party liable to make delivery the option of paying damages instead. Secondly, it is enacted that "the arbitrators or umpire may, if they think fit, make an interim award." This considerably restricts the scope of the type of person who is addicted to raising complaints and grievances on details of completed works with a view to delaying payment for the bulk of the construction, since the arbitrator may order the payment forthwith, or quite early on in the investigation, of such sums as are admittedly due under the contract; a party whose complaints are legitimate or even substantial is not, on the other hand, prejudiced or penalised by being compelled to pay without delay whatever is indisputably due. More important still is the consideration that the power to make an interim award can prove enormously helpful in cases where two issues are joined between the parties, namely, liability and *quantum*; where damages are claimed in respect of defective or delayed construction, the assessment of the *quantum* of damages may be a protracted process, and it is often of prime importance to the parties to know which of them is liable as soon as possible, so that they may allow for such contingent liability in their accounts; the actual calculation may then, without the gravest inconvenience, await the further process of adjudication by the arbitrator. Moreover, by Sec. 9 (1) of the new Act, "an award or any part of an award" may be stated in the form of a special case for the *decision* of the court (not merely the *opinion* of the court); and, by Sec. 9 (2), "a special case with respect to an interim award may be stated, or may be directed by the court to be stated, notwithstanding that proceedings under the reference are still pending."

Where the award directs the payment of a sum of money such sum is henceforth to carry interest, at the same rate as a judgment debt, as from the date of the award, unless the arbitrator specifically directs to the contrary (Sec. 11 of the 1934 Act).

Standard Contract.

Perhaps the most revolutionary change directly affecting the engineer is that which is enacted by Sec. 14. A party is empowered to apply to the court for leave to have a submission to arbitration revoked, or for an injunction to restrain the proceedings, on the ground that the arbitrator is not, or may not be, impartial—even though such party expressly contracted to refer disputes or differences to that arbitrator, and such arbitrator could not be expected to be wholly immune from possible temptation to act with partiality, having regard to his relationship to the other party to the dispute; such an arbitrator may be actually designated by name in the agreement to submit, or the mode of nominating an arbitrator may be therein designated, so that in either event the parties both knew from the outset who the arbitrator was to be, or from which class he was to be selected. This innovation, accordingly, entrenches deeply upon the hitherto well-established doctrines of the "sanctity of contract," and we may well ask for the reasons lying behind its introduction.

Engineering and building contracts tend to assume standardised forms, and such forms commonly include an arbitration clause; such a clause frequently contemplates decisions on the site (then and there) made by the engineer, and binding upon the contractor executing the works and the other party to the contract for whom the work is undertaken. Frequently, again, it contemplates a "full-blown" arbitration, and, in any event, nothing is more common than to make payments to the contractor from time to time contingent upon his obtaining the certificates of the engineer—when the engineer occupies the position of a *quasi*-arbitrator. In so far as the engineer is thus made judge in his own cause (since he must in very many instances adjudicate upon work for which he himself has been responsible), the position cannot, it must be conceded, be regarded as altogether satisfactory. Where such an arbitrator is "imposed" upon a contracting party by a clause printed, generally in diminutive type, in a long and complex form of contract, it may be thought to be an unfortunate "imposition"; on the other hand, it is pertinent to observe that contractors should not gaily and carelessly put their signatures to documents which they insufficiently understand. They can entertain no legitimate grievance if they were afforded the opportunity of perusing and appreciating the terms of the contract before they bound themselves to it. Under the previously existing law a party could evade the submission of his differences or disputes to an arbitrator whose possible partiality became known to him only after he had agreed to the contract, and there was a great deal to be said in favour of such a rule of law designed to deal with circumstances which might show something approaching fraudulent concealment, or, at least, lack of complete candour. The new law protects a party not merely against his opponent's fraud or lack of candour, but also against his own rashness; but if it succeeds in freeing the engineer from the lingering suspicions which sometimes survive in the mind of the party against whom, as arbitrator, he has awarded, it will serve its purpose. For, as the learned Lord Chief Justice of England has observed: "It is highly important not merely that justice shall be done, but that it shall manifestly appear to be done." Engineers themselves, too, will rejoice in new-found freedom, in many cases, from an invidious position.

Biassed Engineer.

One or two cases under the old law will illustrate its reasons as well as those prompting the reform. In *Kimberley v. Dick* (1871), L.R. 13 Eq. 1, the court said that it would be inequitable to compel a builder or contractor to submit to arbitration on questions such as the amounts, if any, to be allowed for extras by the adjudication of the engineer or architect or surveyor under the contract who, unknown to the builder, had undertaken to the building owner that the cost of the works should in no event exceed a specified sum, which sum did not permit of any extras as claimed.

In the case of *Re Donkin and Leeds Canal Company* (1893), 9 T.L.R. 192, a contract for the construction of works for the Company provided that disputes or differences between the contractor and the Company should be referred to the Company's engineer; the contractor applied to the court to have the submission revoked, on the ground that the engineer had ordered extras unnecessarily and by his own delays had held up the work, which issues he would have to try as arbitrator; the court declined to accede to the application on the ground that those particular issues did not form the most substantial part of the differences between the parties.

Jackson v. Barry Railway Company (1893), 1 Ch. 238, was a case where the court said that even if the Company's own engineer might be thought to be not the most suitable arbitrator who might have been selected by the parties to the contract (for the construction of a dock), seeing that his own decisions in the course of the construction would be the very issues to be adjudicated upon, there was, nevertheless, no sufficient ground for restraining the arbitration. The contractor had agreed by the contract itself to have him as arbitrator, and a contractor must be presumed by the court to know what he is about when, with his eyes open, he agrees to a term in the contract which, subsequently, he feels may not prove to be to his maximum advantage. The court did not desire to "approach such curiously coloured contracts with a view to upset them, for to do so would be to attempt to dictate to the commercial world the conditions under which it should carry on its business."

A contractor may throw his net wide in an effort to catch out the engineer as suffering from bias rendering him unfit to arbitrate. Thus, in *Eckersley v. Mersey Docks* (1894), 2 Q.B. 667, an unsuccessful application was made to the court to remove the Mersey Docks engineer from his position as arbitrator on the ground of probable bias. Work in an adjoining dock was being executed under the superintendence of a son of the engineer in question at the same time as the work in dispute. One of the allegations made by the contractor, who now sought to evade the arbitration, was that it was owing to the negligence of the son of the engineer on his work that water had escaped from his dock into that on which the contractor was working, thereby causing damage to the contractor, in respect of which he now claimed. The contractor had entered into the agreement with the Mersey Docks Board, well knowing the condition in the contract that all disputes and claims must be referred to the engineer of the Board, and the court declined to say that the engineer of the Board would hold in their favour simply because not to do so would be to criticise the work of his own son engaged on another contract.

Additional powers are conferred (by Sec. 8 of the 1934 Act, as set forth in the First Schedule) upon the court to make orders for arbitration proceedings similar to such as may be made in court proceedings; and they include orders providing for security for costs and for the amount in dispute; interim custody, preservation or sale of goods in dispute; and authority to enter upon land or buildings in the possession of one of the disputing parties, or to conduct experiments "necessary or expedient for the purpose of obtaining full information or evidence."

Misconduct.

Engineers have had occasion from time to time to resent the terms of Sec. 11 of the 1889 Act when they have sat as arbitrators or umpires and application has been made to the court to remove them for "misconduct," since such an application may appear to involve reflections upon their moral character or standard of professional ethics, and the new Act has been at pains to avoid this grievance by Sec. 15, which amends the statutory phraseology, so that Sec. 11, in its amended form, now reads: "Where an arbitrator or umpire has misconducted himself *or the proceedings* the court may remove him. Where an arbitrator or umpire has misconducted himself *or the proceedings* or an arbitration or award has been

improperly procured, the court may set the award aside." (The words here italicised are new.) It will, therefore, no longer be necessary for the court to stress, when it does feel impelled to remove an arbitrator, the fact that nothing detrimental to the arbitrator's morality or professional skill is to be implied from the decision, as it had to do, for example, in *Williams v. Wallis and Cox* (1914), 2 K.B. 478; there, Mr. Justice (as he then was) Atkin explained that "'Misconduct' does not necessarily involve personal turpitude on the part of the arbitrator; it does not really amount to much more than such a mishandling of the arbitration as is likely to amount to some substantial miscarriage of justice, and one instance that may be given is where the arbitrator refuses to hear evidence upon a material issue." Mr. Justice Lush put it this way: "If an arbitrator for some reason which he thinks good declines to adjudicate upon the real issue before him, or rejects evidence which, if he had rightly appreciated it, would have been seen by him to be vital, that is within the expression 'misconduct' in the hearing of the matter which he has to decide, and misconduct which entitles the person against whom the award is made to have it set aside." In short, we now have statutory authority for the proposition that a first-class engineer may make but a second-class Judge—the law requires of every arbitrator that he shall conduct the reference in a judicial manner, and, when all is said, judicial skill is a specialised faculty, just as is engineering skill. The Act indicates in this—perhaps comparatively small—reform, as in the major innovations which it effects, a desire on the part of the law to facilitate and popularise arbitrations rather than to restrict them. For the law has long recognised that where technical issues of engineering, building, accounts and the like are involved arbitrators selected by the parties affected, from the ranks of the profession or trade whose works are in issue, are likely to be able to adjudicate more speedily and perhaps with more complete satisfaction to all concerned than Judges themselves, whose prime function is to decide issues of law upon evidence adduced; and evidence of a technical nature when presented to a court of law may involve the tendering of testimony of experts whose services may be dispensed with, or reduced to a minimum, when such is offered to a tribunal manned by experts who may "take as read" much which, before a court of law, must be examined meticulously.

FEES.

Another consideration which has often dissuaded engineers from accepting the office of arbitrator which they might admirably discharge has been the possibility that their fees will be disputed, with the consequent unpleasantness which may thereby be engendered. A disputant may not be in a position accurately to assess the value of professional time and skill which has been placed at his disposal in the adjudication of his grievances by an arbitrator; in the past, the naming by an arbitrator of a fee for his services which the party desiring to take up the award has thought excessive has been followed by application to the court to set aside the award, on the ground that the arbitrator's fee is grossly excessive and, therefore, indicative of "misconduct." Sec. 13 of the new Act provides for taxation of fees by the court; if the disputant is required to pay a fee, which he considers excessive, before the arbitrator will deliver up his award he may now have the award delivered up on payment into court of the fee demanded, and the arbitrator will, in due course, become entitled only to such portion as is allowed on taxation. This recourse to the court may, however, be excluded by an agreement, made in writing, between the party and the arbitrator, fixing the latter's remuneration. Sec. 3 of the 1934 Act requires arbitrators to enter upon, and proceed with, the reference with "all reasonable dispatch," and failure to do so may involve not only removal from office by the court, but also disallowance of remuneration.

UMPIRES.

As to umpires, the old law provided (1889 Act, First Schedule, *b*) as one of the terms implied in submissions that "if the reference is to two arbitrators, the two arbitrators may appoint an umpire at any time within the period during which they have power to make an award"; the new Act substitutes for this the rule that "if the reference is to two arbitrators, they shall appoint an umpire immediately after they are themselves appointed" (Sec. 5). Further, it is enacted (by the same Section) that at any time after an umpire has been appointed, "however appointed," the court may order that the umpire shall enter upon the reference in lieu of the arbitrators and as if he were sole arbitrator, notwithstanding anything to the contrary contained in the arbitration agreement; this it may do upon the application of any party to the reference—thus again invading "the sanctity of contract."

Resort to umpires is further popularised by the provisions of Sec. 4 of the 1934 Act; henceforth, if an arbitration agreement provides for the appointment of three arbitrators, the third to be appointed by the two arbitrators who have been nominated by the disputants (one by either side), then the agreement is to take effect as if it provided for the appointment of an umpire and not of a third arbitrator at all. If three arbitrators are nominated by any other means than the above they may still sit as three arbitrators, but a majority decision shall be binding.

DEATH AND BANKRUPTCY.

Finally, we may glance at the important amendments relating to death and bankruptcy respectively. As to death, the old rule was that unless the parties expressly contracted to the contrary the death of a disputant automatically terminated the authority of an arbitrator, with the result that time, labour, and expense were thrown away; and even the power of contracting out was severely limited by the maxim "*actio personalis moritur cum persona*" (a personal action dies with the person); for a personal action died with the death of the claimant if it were contemplated that it should be brought in a court of law, and the same limitation applied if it were desired to pursue the claim before an arbitrator; new rules are now set forth in Sec. 1 of the Act, providing that the death of a party shall no longer operate to discharge an arbitration agreement, nor shall the death of the party nominating him revoke the authority of an arbitrator; and the Law Reform (Miscellaneous Provisions) Act, 1934, has made very serious inroads upon the maxim itself; Sec. 1 of the Arbitration Act, 1934, contains a saving that the new arbitration rule is not to affect any existing rule of law which extinguishes a right of action at death—so that the saving clause has now, by the Law Reform Act, lost much of its width. This class of case may affect engineers where claims arise out of the construction of works for which they are responsible when such construction occasions, or is alleged to have occasioned, damage to passers-by or to neighbours. The new rules regarding bankruptcy (Sec. 2) are:—If a contract included an arbitration clause, the trustee in bankruptcy who adopts the contract may avail himself of the right to arbitration, and likewise he may be compelled to submit to arbitration; and, an arbitration agreement to which a bankrupt became a party prior to his bankruptcy may be kept alive by leave of the court granted on the application either of the trustee in bankruptcy (with the concurrence of the committee of inspection) or of any other party to the contract.

The new Act, it will be seen, follows and extends the lines along which courts of law have long proceeded in dealing with arbitrations; their general policy was admirably expressed by Lord Justice Scrutton, in *Metropolitan Tunnel and Public Works, Limited, v. London Electric Railway Company* (1926), 1 Ch. 371, where he said: "It is becoming increasingly the practice to insert in contracts of building and engineering a clause by which the parties agree to refer all their disputes, or a certain class of them, to an arbitrator. It is also a very common practice for a party who has agreed to refer all his disputes to an arbitrator to say, when a question arises, that he would rather not do so, and to bring an action in the King's Courts. It is eminently desirable, in all business matters, that parties who have made a contract should keep it." The same eminent Judge had said, in *Ayscough v. Sheed Thomson and Company* (1923), 28 Commercial Cases, 203: "If people do not like the Courts they should keep clear of them, and if they go to arbitrators they should stand by their decision and not try to upset it in the Courts."

SIXTY YEARS AGO.

By name at least, Captain Shaw will be remembered as long as "Iolanthe" continues to be performed. He deserves remembrance, however, for other qualities besides those which have led to his immortalisation at Gilbert's hands. As chief of the Metropolitan Fire Brigade he took his professional fire-extinguishing duties very seriously. Indeed to him we may justly ascribe much of the credit for establishing London's fire brigade service on its present highly efficient basis. In his annual reports he revealed himself as a close student of his subject. In 1875 the facts which he disclosed, as summarised in an article, "London Fires," which we published in our issue of April 23rd of that year, were both disquieting and perplexing. From 1833 to 1874 there had been, with but minor fluctuations, a steady increase in the number of fires in the London area—from 458 in the earlier year to 1573 in the later. Some increase was naturally to be expected in view of the growth in the population. The disquieting fact, however, was that the increase in the number of fires was quite out of keeping with the increase in the population. In 1833 there was one fire for every 3734 persons within the area. In 1874 the figure was one for 2162. In other words the number of fires in the latter year was fully 72 per cent. greater than what it should have been if the ratio to population characteristic of 1833 had been preserved. Extending Captain Shaw's analysis, we examined the statistics over five and ten-yearly periods, but, try as we would, we could extract little comfort from them. It was clearly established that the growth in the number of fires was gaining on the growth in the population and, mathematically, we foresaw the time when everyone would be burnt out. The greatest consolation that could be offered was the fact, revealed by the statistics for the preceding ten years, that there was a clear tendency towards a decrease in the percentage of fires classified as serious. Whereas in 1865, 34 per cent. of the fires which occurred were described as serious, in 1874 the serious fires amounted only to 10 per cent. of the total number. Captain Shaw's figures perplexed him and his contemporaries. They are no less perplexing to us to-day. Fire protection measures were certainly much less advanced in 1874 than they are now. Nevertheless they were considerably more developed then than they were in 1833. In spite, however, of the progress that had been made the chances of an outbreak in the later year were actually greater than in the earlier year. Some adverse factor, or group of factors, had been encouraged by the growth in the population and had swamped the benefit to be expected from the improvements in fire protection. All that these improvements had effected, seemingly, was to reduce the severity of the damage done by an outbreak; they had done little or nothing to diminish the chances of a fire occurring. What was the nature of the countervailing adverse factor? Had Captain Shaw been more of a philosopher than of a statistician he might have enlightened us. As it is we have to rest content with the somewhat unsatisfying general conclusion that, in his day at least, a given number of people concentrated in one town was more liable to suffer from outbreaks of fire than the same number of people distributed over several towns.

Literature.

SHORT NOTICES.

Boiler Feed Water: A Concise Handbook of Water for Boiler Feeding Purposes. By Percy G. Jackson, F.I.C. Third edition. Revised and enlarged. London: Charles Griffin and Co., Ltd. 1935. Price 6s.—This little book has been before boiler users for many years, for the first edition appeared in 1919. It was written at a time when the author was working as chemist to the National Boiler and General Assurance Company, Ltd., and, therefore, in almost daily touch with feed-water problems. It is essentially a practical book, and the fact that this, the third, edition differs from its predecessor only by slight revisions and the addition of a chapter, shows how little change has taken place in boiler treatment in recent years. The new views are summarised in a chapter on scale formation and caustic embrittlement. The latter has become rather a bogey, and we are glad to observe that Mr. Jackson is not frightened by it. He says: "It is probably rare, nowadays, at least, in this country, and with reasonable care, it ought never to be found." If we listened to the tales of the caustic embrittlement alarmist, we should wonder why any boiler existed for more than a few months. To the question of priming the author devotes too little attention. In turbine engineering the "carry-over" of deposits from boilers presents problems of great importance which cannot be easily either answered or removed. We would commend to his consideration Mr. Glinn's recent paper to the Institution of Mechanical Engineers and the discussion upon it.

Hutchinson's Technical and Scientific Encyclopædia. Vol. I, A to Direction Finding. Edited by C. F. Tweny and I. P. Shirshov. London: Hutchinson and Co. (Publishers), Ltd. Price 28s. net.—This volume, the first of four, gives an idea of the whole encyclopædia which is being published in weekly parts. The scope of the work would appear to be unlimited, and covers practically every branch of science, many of the subjects being dealt with in such detail as is usually found in text-books. A large number of well-known experts have contributed to the volume, and each has obviously gone to much trouble to give the fullest information on his subject in a concise yet not too abbreviated manner. Terms and apparatus incidental to the various sciences, industries, and trades are defined and described, and, where necessary, illustrations and diagrams are given. It is only natural that with a work of this kind omissions and faults may be found, but from our examination of the first volume they must be few and are well compensated for by the high standard and wealth of information that is given. We look forward to the publication of the remaining volumes of the series, which, when complete, will undoubtedly prove a valuable reference work for all branches of science.

The Unified Transport System of the U.S.S.R. By K. N. Tverskoi. London: Victor Gollancz., Ltd., 14, Henrietta-street, W.C.2. Price 3s. 6d. net.—This is the tenth book of a series being published to describe the various aspects of economic, social, political, and national life under the Soviet system, and as its title indicates deals with all classes of transport in the country. The fact that the Soviet Union covers an area of some 21,274,000 square kilometres, having a population of 168 million people, with widely distributed industrial and agricultural areas, makes the organising of an efficient transport system a colossal task, and the author describes the numerous schemes in hand and already completed for the linking up of the country by road, rail, canal, sea, and air lines. Throughout the book runs a strain which makes it clear that all the schemes have been made possible and practicable by the political control under which all work is carried out in the U.S.S.R. It will be of interest to many who follow the progress of the Soviet Union.

Modern Radio Communication. By J. H. Reyner. Vol. I. Fifth edition. London: Sir Isaac Pitman and Sons, Ltd. 1935. Price 5s.—This book, first issued in 1923, is too well known to call for any special commendation. It is designed for students, and covers the syllabus of the C. and G. Examination, and is suitable for candidates for the P.M.G. Certificate. The present edition brings the subject up to date, but in substance and in other respects does not differ from its predecessors. It can be safely recommended for the use of amateurs as well as students.

BOOKS RECEIVED.

The Investigation of Atmospheric Pollution, Twentieth Report. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 5s. net.

The Heat Treatment of Steel. By A. C. Macdonald, B.Sc. London: The Draughtsman Publishing Company, Ltd., 96, St. Georges-square, S.W.1. Price 2s. net.

Directory of Shipowners, Shipbuilders, and Marine Engineers, 1935. London: The Directory Publishing Company, Ltd., 33, Tothill-street, S.W.1. Price 20s. net.

Measuring the Existing Stresses in Masonry Structures.*

By N. DAVEY, B.Sc., Ph.D., &c.

THE successful conservation of many of our ancient masonry structures must depend largely upon a knowledge of the position of the points of highest stress concentration. The stress distribution in such structures is often extremely complex and defies exact analysis. So that precautionary measures can be taken to ensure stability, it is therefore desirable that some direct means of determination of the stress in the masonry *in situ* should be available. A method of making this determination has been developed at the Building Research Station, and is described below. The work has been much accelerated by the interest and support given by Sir Basil Mott, C.B., who has

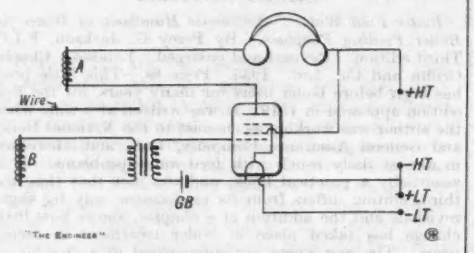

FIG. 1—PRINCIPLE OF ACOUSTIC GAUGE

very generously contributed towards the cost of the work.

A suitable strain gauge is mounted on the masonry block and vertical slots are cut each side of the gauge at an angle of 45 deg. to the surface of the block, in such a manner that the slots meet. A triangular prism held at the ends is thus formed. A horizontal cut is then made at the base of the prism, so that it is released from the surrounding masonry. As the specimen is released it is relieved of load and its length changes; these changes being recorded by the strain gauge mounted upon it. The specimen can then be completely removed by cutting a second horizontal slot at the top, and the determination of

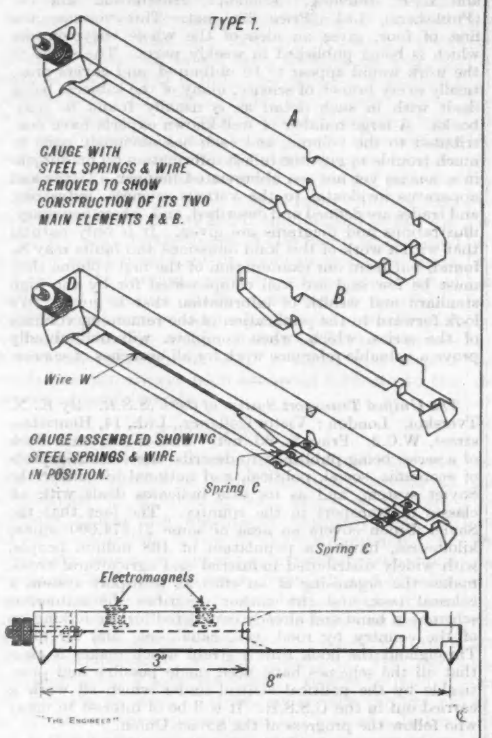

FIG. 2—ACOUSTIC GAUGE FOR STONEWORK

the elastic modulus and other properties made in the laboratory.

From the data obtained it is possible to estimate the stress of which the specimen has been relieved when severed from the block.

For making measurements of this nature, the strain gauge should satisfy certain essential requirements. Of these, the following are perhaps the most important:—

(*a*) A high degree of sensitivity, capable of recording a strain of 1×10^{-6} or less.

(*b*) Stability and low susceptibility to external vibrations.

(*c*) Use in remote places and having distant control.

(*d*) Suitability for use on friable materials.

(*e*) Ease of calibration and linearity of response, if possible.

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Of the various types of gauge, the acoustic type appeared to be the most suitable. The principle upon which this gauge operates is that the frequency of vibration of a stretched steel wire clamped to the

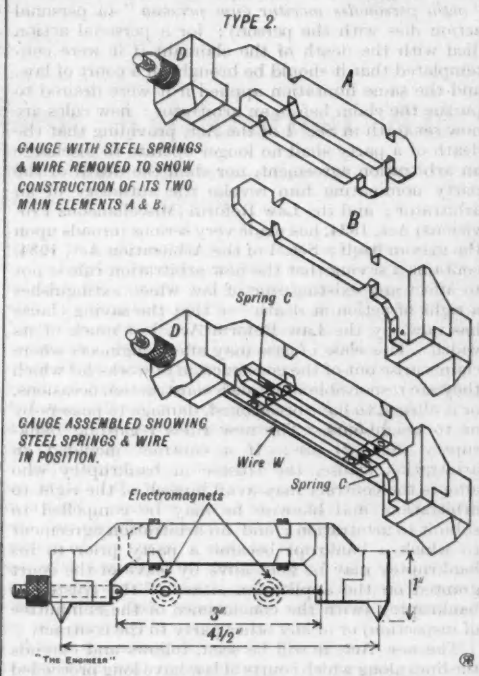


FIG. 3—ALTERNATIVE FORM OF GAUGE

structure under observation is matched against the frequency of a second steel wire, to which known tension can be applied. Gauges operating on this principle have been used for some while in several

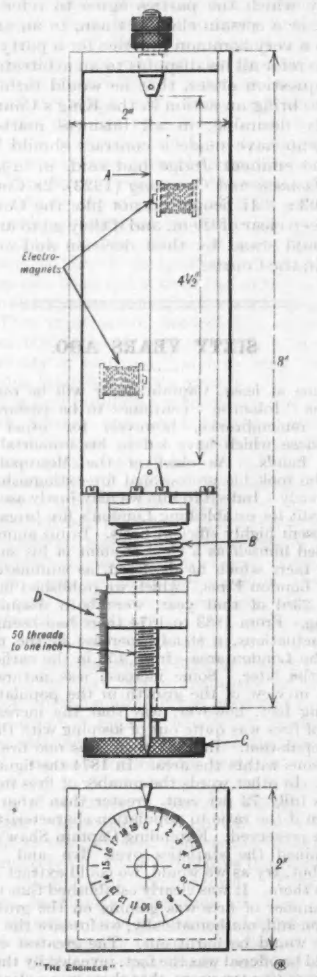


FIG. 4—STANDARD TUNING WIRE

countries, viz., Russia,[1] France,[2] and Germany, in the last of which the well-known Maihak gauge has been produced commercially.[3] The stretched wires are plucked magnetically by means of electro-magnets, and the notes emitted by each wire are heard in telephones.

In the gauge developed at the Building Research Station the wire is kept in a constant state of excitation by the use of a low-frequency pentode valve. The method is shown in Fig. 1, and is similar in principle to that which has been used for some time past for maintaining tuning forks in constant vibration.[4] When the anode battery (H.T.) is switched on, there is a surge of current through the coil A which plucks the wire and sets it in vibration. The vibration of the wire induces an alternating e.m.f. in the coil B,

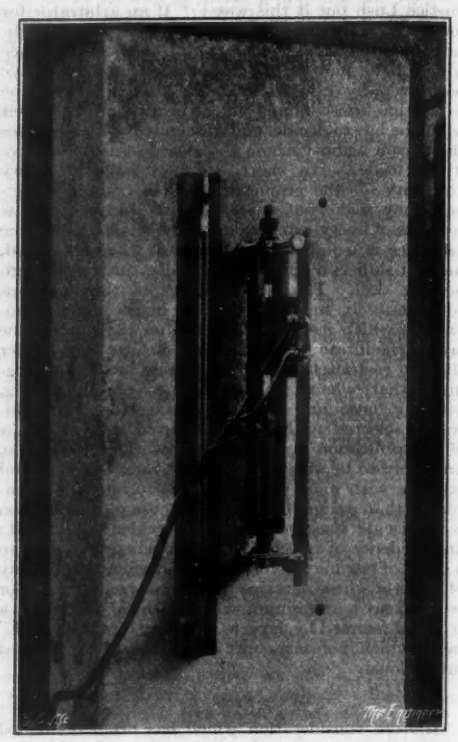


FIG. 5—GAUGE IN POSITION

which produces an alternating potential on the grid of the valve of the same frequency as that of the wire. The valve amplifies this alternating voltage and produces an alternating current in the anode circuit, so that the vibration of the wire is continuously maintained. It was found necessary to use a pentode valve, as in Fig. 1, or two ordinary low-frequency triode valves.

A certain amount of tension has to be applied to the wire initially in order to obtain a frequency of vibration that can be heard comfortably in the telephone, and also to remove any kinks in the wire. This initial tension is transmitted to the knife edges of the Maihak type gauge, and it is at once apparent that when used on friable materials, such as soft stonework, crumbling

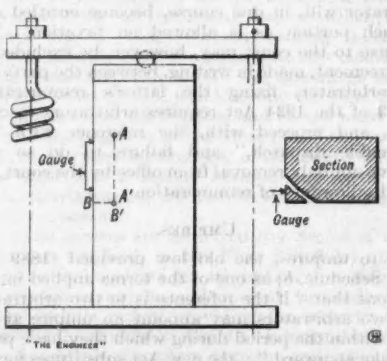


FIG. 6—LABORATORY TEST BLOCK

of the material under the knife edges may occur, resulting in slipping and errors in observations.

It has been necessary to depart, therefore, from the usual type of acoustic gauge, and the types shown in Figs. 2 and 3 have been developed. In this type of gauge the initial pull is applied to the wire W without its being transmitted to the two knife edges, the pull being taken on the steel springs C. This adjustment is made by means of the nut D. The body of the instrument is in two parts A and B, conveniently held by transverse springs C so as to allow a slight relative longitudinal motion. One knife edge is rigidly secured to one part of the body and the other knife edge is rigidly secured to the other part. One

[1] N. Dawidenkow, "An Acoustical Method of Measuring Stress," *Journal of Applied Physics*, Leningrad, 1928, 5, 37–46.

[2] André Coyne, "Nouveau Procédé d'Auscultation des Ouvrages en Béton ou Béton Armé, et Notamment de barrages," *Le Génie Civil*, 1932, 100 (2), 225.

[3] "An Acoustic Process for the Examination of Stress," THE ENGINEER, August 10th, 1934, page 142.

[4] W. H. Eccles, Phys. Soc. Proc., 1919, xxxi, 269; W. H. Eccles and F. W. Jordan, *Electrician*, 1919, lxxxii, 704.

end of the wire is secured adjustably to portion A of the body, while the other is secured rigidly to portion B which carries the second knife edge.

In Figs. 2 and 3 the gauges are shown with the steel springs and the wire removed to show the construction of the members A and B, and also assembled. The minor constructional details regarding the electro-magnets which excite the wire and pick up the vibrations have been intentionally omitted from the sketches, in order to make clear the construction of the main essentials of the gauge.

The frequency of vibration of the gauge wire changes as its length changes, and is matched against the frequency of vibration of a standard wire. The frequency of the latter is changed at will by altering the load applied to the wire A (Fig. 4) by means of a spiral spring B, which can be extended by rotating the micrometer C. In practice the standard wire is tuned to the same frequency of vibration as the gauge wire. When strain occurs in the test piece, the frequency of vibration of the gauge wire changes. The spring B of the standard wire is extended or compressed by rotation of the micrometer, in order to bring the frequency of vibration to the same amount as that of the gauge wire. The change in length of the spring, which is proportional to the load applied to the wire, is measured by means of the scale D and the graduated micrometer head C. This arrangement of the standard wire is a departure from the usual type, and is highly sensitive. Using Type 2 gauge (Fig. 3), it has been found possible to record very easily strains of the order of $0{\cdot}2\times10^{-6}$.

The gauge is clamped on the masonry block in the manner illustrated in Fig. 5. Contact between the clamps and the gauge is made through a steel ball mounted directly above the knife edges. The clamp is held firmly to the masonry by inserting the two legs of the clamp into holes drilled in the masonry at an angle of 45 deg. to the surface. As the clamp is tightened on the gauge, these legs make rigid connection with the masonry. As an additional precaution against crumbling of the comparatively friable masonry beneath the knife edges, the masonry is impregnated at these points with a dilute solution of cellulose acetate in acetone.

Some difficulty was experienced in arriving at the best manner of cutting the vertical slots in the masonry at an angle of 45 deg. to the surface. Various types of rotary steel and carborundum saws were tried without success. Attempts were made to mill the slots with millend cutters, but the best results have been obtained by drilling a series of adjacent holes by means of a template mounted with Rawlplugs, as shown in Fig. 5.

The first tests in the laboratory were made on a block of Bath stone, 24in. long, 10in. by 4½in. cross section, which was mounted as shown in Fig. 6 so that the load could be applied through spiral springs. Two holes A A′ were drilled across one corner at an angle of 45 deg. The gauge (Type 1) was mounted between these holes, as shown. (It will be noted that in the early laboratory tests a triangular specimen was cut from a corner of the masonry block, this being the simplest case to deal with.)

The specimen was loaded with a load of 3·83 tons per square foot (59·6 lb. per square inch). The strain recorded for this intensity of stress amounted to $29{\cdot}6\times10^{-6}$. The vertical slot A A′ was cut with the gauge in position. A certain amount of bending occurred owing to the method of fixing the clamps. This has been rectified in subsequent tests by using the type of clamp already described. The slot B B′ was then made with a hacksaw and the strain recorded amounted to $31{\cdot}2\times10^{-6}$.

The next test was a repetition of that just described, and was made on a specimen cut from the diagonally opposite corner of the same Bath stone block (2). The tests were again made at a constant temperature of 64 deg. Fah., and the vertical slot A A′ was cut with the gauge (Type 1) in position. The applied stress was 62·5 lb. per square inch and the recorded strain was 33×10^{-6}. When the specimen was severed by cutting the horizontal slot B B′, a strain of $33{\cdot}5\times10^{-6}$ was recorded. A complete record of the test is given in Fig. 7.

In a third series of tests, Fig. 8, the vertical slots were cut at angles of 45 deg. to the surface by drilling in the manner already described, in the middle of one face of a large Bath stone block. The tests were made in a laboratory having uncontrolled temperature. The stress applied was 78·3 lb. per square inch, the strain due to this stress being $28{\cdot}1\times10^{-6}$. When the horizontal slot was cut, the strain produced by the release of stress was 25×10^{-6}.

It was apparent from these preliminary tests that a very fair estimate of the intensity of stress on a block of masonry could be obtained by this method, and in consequence arrangements were made for a trial to be carried out on a block *in situ* in a large building in London. The exposed face of the stone, which was situated in a pier carrying a considerable load, measured approximately 35in. by 22in. The stone was Burford, and comparatively soft, and was bedded between blocks of Portland stone. The gauge (Type 1) was mounted at the centre of the exposed face of the block and the two vertical slots were cut by drilling, as already described, a record of any change between the gauge points being obtained (Fig. 9). When the triangular prism was released from the surrounding stone, a strain of $96{\cdot}8\times10^{-6}$ (allowing for slight temperature correction) was recorded. On examination of the stone in the laboratory, its average crushing strength was found to be 54 tons per square foot, and the average value for the elastic modulus $2{\cdot}26\times10^{6}$ lb. per square inch.

The stress on the Burford stone block was estimated to be 14·05 tons per square foot, taking the value of E to be $2{\cdot}26\times10^{6}$ lb. per square inch. This result suggests that this particular Burford stone block is loaded with a factor of safety of 4 or less.

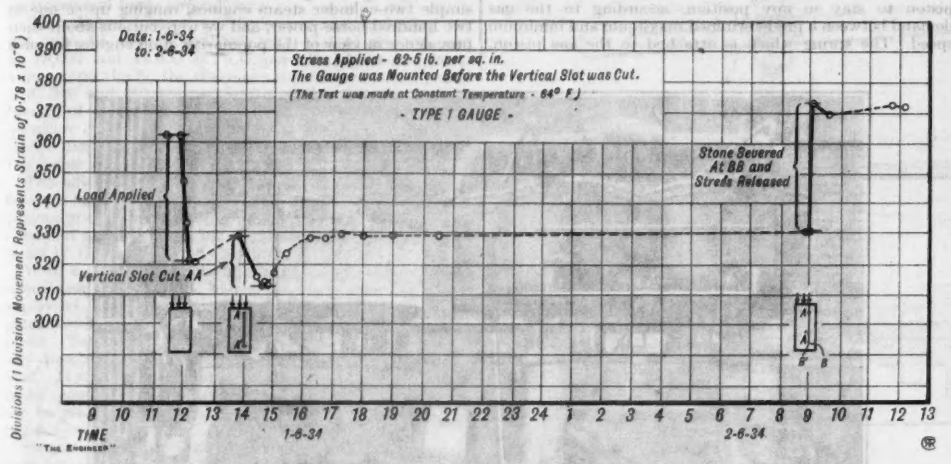

Date: 1-6-34 to: 2-6-34
Stress Applied - 62·5 lb. per sq. in.
The Gauge was Mounted Before the Vertical Slot was Cut.
(The Test was made at Constant Temperature - 64° F.)
- TYPE 1 GAUGE -
Load Applied
Vertical Slot Cut AA
Stone Severed At BB and Stress Released
Divisions (1 Division Movement Represents Strain of 0·78 x 10⁻⁶)
TIME
1-6-34
2-6-34
"The Engineer"

FIG. 7—RECORD OF LABORATORY TEST

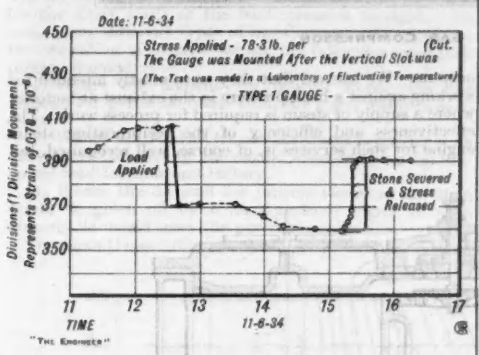

Date: 11-6-34
Stress Applied - 78·3 lb. per
(Cut.
The Gauge was Mounted After the Vertical Slot was
(The Test was made in a Laboratory of Fluctuating Temperature)
- TYPE 1 GAUGE -
Load Applied
Stone Severed & Stress Released
Divisions (1 Division Movement Represents Strain of 0·78 x 10⁻⁶)
TIME
11-6-34
"The Engineer"

FIG. 8—TEST RECORD

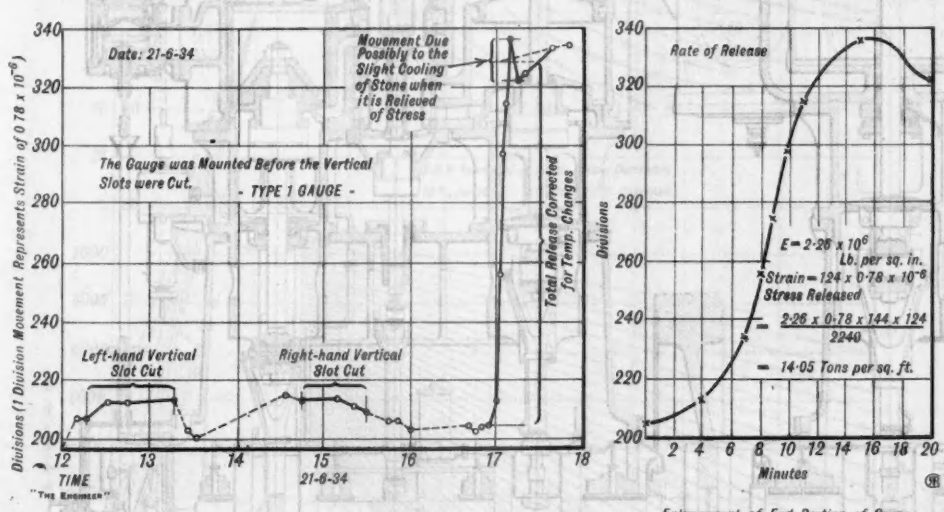

Date: 21-6-34
Movement Due Possibly to the Slight Cooling of Stone when it is Relieved of Stress
The Gauge was Mounted Before the Vertical Slots were Cut.
- TYPE 1 GAUGE -
Total Release Corrected for Temp. Changes
Left-hand Vertical Slot Cut
Right-hand Vertical Slot Cut
Divisions (1 Division Movement Represents Strain of 0·78 x 10⁻⁶)
TIME
21-6-34
"The Engineer"
Rate of Release
E = 2·26 x 10⁶ Lb. per sq. in.
Strain = 124 x 0·78 x 10⁻⁶
Stress Released
= 2·26 x 0·78 x 144 x 124 / 2240
= 14·05 Tons per sq. ft.
Divisions
Minutes
Enlargement of End Portion of Curve

FIG. 9—RESULTS OBTAINED FROM A BLOCK IN SITU

The Quarter's Shipbuilding Returns.

THE statistics issued by Lloyd's Register of Shipping regarding merchant vessels under construction at the end of March last show that in Great Britain and Ireland there is a decrease of 41,019 tons in the work in hand as compared with the figures for the previous quarter. In this connection, however, it may be remarked that the tonnage of new vessels completed during the past three months has been greater than usual, and that the present total of tonnage under construction—555,815 tons—is, nevertheless, 74,375 tons greater than the tonnage which was being built at the end of March, 1934.

The tonnage on which work was suspended at the end of March last amounted to 23,288 tons, being composed entirely of steamers. About 67,000 tons—12 per cent. of the tonnage now being built in this country—are intended for registration abroad or for sale.

The tonnage now under construction abroad, excluding Russia, for which no figures are available—713,719 tons—is about 59,000 tons more than the work which was in hand at the end of December, 1934, and is the highest quarterly total recorded since June, 1932. Tonnage, included in the total in hand abroad, on which work has been suspended amounts to 2570 tons of steamers and 6628 tons of motor ships. The leading countries abroad are :—Germany, 194,770 tons ; France, 120,899 tons ; Sweden, 83,213 tons ; Japan, 79,491 tons ; Denmark, 66,640 tons ; and Holland, 60,371 tons.

The total tonnage under construction in the world, excluding Russia, for which no figures are available, amounts to 1,269,534 tons, of which 43·8 per cent. is being built in Great Britain and Ireland, and 56·2 per cent. abroad. The world total shows an increase of about 18,000 tons over the figures at the end of December last, and is, with the exception of that for September last, the highest since March, 1932.

In Great Britain and Ireland 144,386 tons were commenced during the last three months, showing an increase of 50,958 tons compared with the corresponding total for the December quarter. During the quarter ended March, 1935, 106,097 tons were launched in Great Britain and Ireland, a decrease of 100,430 tons as compared with the previous quarter. Similar figures for abroad are 177,281 tons commenced, and 173,166 tons launched, showing, as compared with the previous quarter, an increase of 67,812 tons in the tonnage laid down and a decrease of 4689 tons in the tonnage launched.

Steam and motor oil tankers under construction in the world amount to 41 vessels of 313,795 tons, of which 10 vessels of 76,765 tons are being built in Germany, 5 vessels of 45,250 tons in Denmark, 6 of 45,210 tons in Holland, 5 of 42,700 tons in Sweden, 6 vessels of 36,550 tons in Great Britain and Ireland, 2 of 17,300 tons in Japan, and 2 of 16,800 tons in the United States of America.

Of the 555,815 tons under construction in Great Britain and Ireland at the end of March, 251,942 tons consisted of motor ships, while at the same date the motor ship tonnage being constructed abroad—464,499 tons—was 216,854 tons in excess of that of the steamers.

The vessels being built in the world at the end of March include 7 steamers and 14 motor ships of between 8000 and 10,000 tons each ; 4 steamers and 22 motor ships of between 10,000 and 20,000 tons ; and 4 steamers and 2 motor ships of 20,000 tons and upwards.

The table respecting marine engines shows that the horse-power of steam engines now being built or being fitted on board amounts to about 775,000 h.p.; this figure includes 50 sets of turbine engines of about 654,000 s.h.p. The horse-power of the steam reciprocating engines—about 121,000 h.p.—amounts to 7·9 per cent. of the total horse-power of marine engines now being built in the world. The figures for oil engines aggregate approximately 752,000 h.p.

Of the merchant shipbuilding in hand throughout the world at the end of March, 848,211 tons, or nearly 67 per cent., are being built under the inspection of Lloyd's Register. Of this total, 519,086 tons, representing more than 93 per cent. of the tonnage being built there, are under construction in Great Britain and Ireland ; while, of the tonnage being built abroad, 329,125 tons, or over 46 per cent., are being constructed under the inspection of Lloyd's Register.

Gas Compressors for South America.

ON the occasion of a recent visit to Letchworth we took the opportunity of making a tour round the works of Kryn and Lahy, Ltd., where, as we have previously recorded, steel castings of a very excellent quality are produced. This time, however, we were more concerned with the machine shops than with the foundry. It is there that the Browett Lindley engines, originated a generation ago, are now being manufactured. The old business has been transferred from Patricroft, and, together with that of Bumsted and Chandler, has been incorporated with that of Kryn and Lahy.

At the time of our visit there were a number of steam engines and compressors in course of erection in the shops, mostly of the two-cylinder type, and we have chosen a combined set for the subject of our accompanying engraving and drawings.

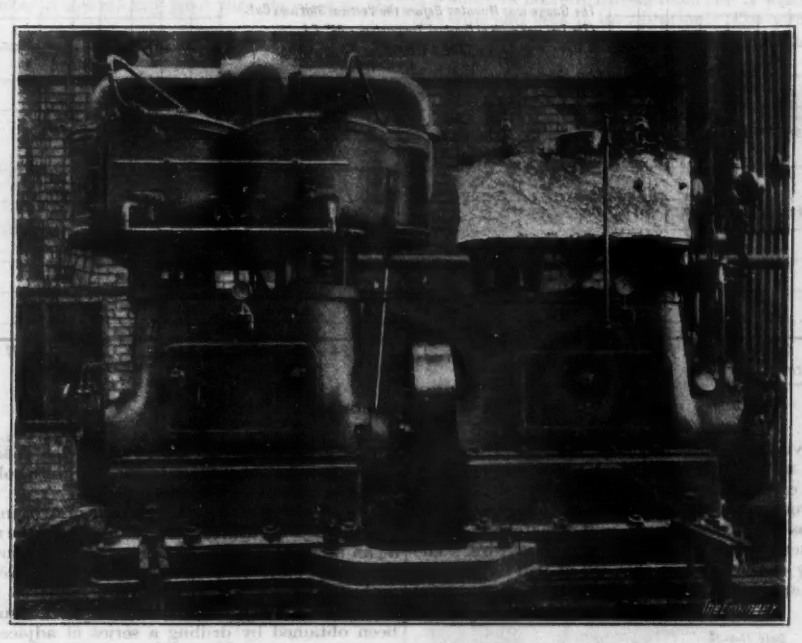
It is one of two machines for compressing gas supplied to the Primitiva Gas Company, of South America. Each set comprises a single-stage, two-crank compressor of the enclosed forced lubrication, double-acting type, having a capacity of 5000 cubic metres of free gas per hour, delivered against a pressure of 7½ lb. per square inch, when running at 375 r.p.m. The compressor is coupled directly with a compound engine of the central valve type capable of developing 130 b.h.p. as a continuous load, when supplied with steam at a pressure of 110 lb. per square inch at the stop valve, and exhausting to the atmosphere. The engines were designed for working also with steam at a pressure of 120 lb. superheated to 550 deg. Fah. The equipment of these engines is very complete, including a tachometer, mechanically driven sight-feed lubricator, and indicator gear for both the engine and compressor.

The engine is fitted with metallic packings for both piston-rods and the valve-rod, the packings for the compressor embodying a lantern ring connected with the suction, so that gas will not leak out into the engine-room.

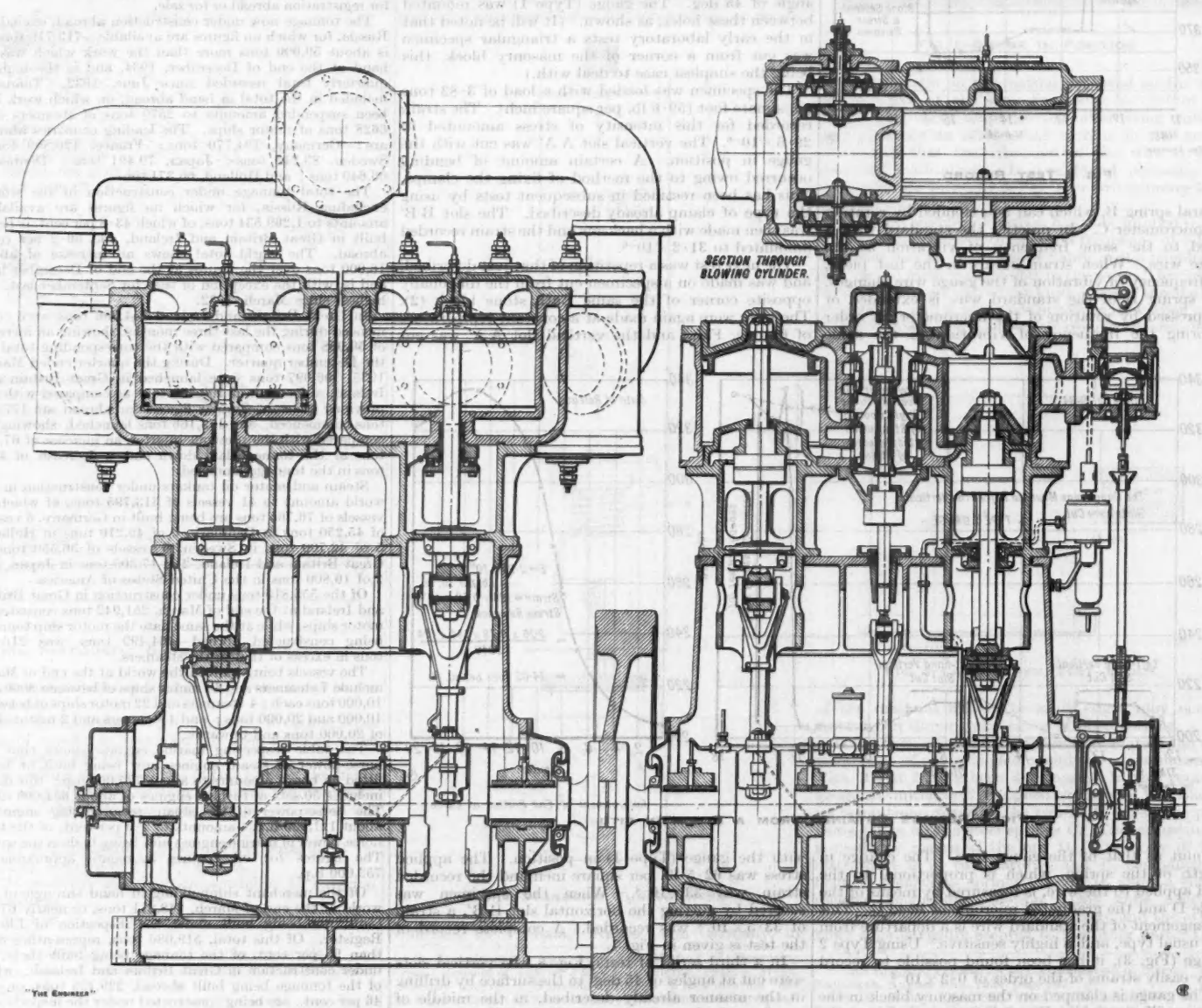
The control gear comprises a relay-operated slowing-down governor on the steam engine, and an outlet governor on the compressor. The slowing-down gear is worked by the oil pressure of the forced lubrication system, and is illustrated by one of our drawings. It operates as follows:—When the gas pressure in the main exceeds the predetermined pressure, it moves a spring-loaded gas piston, which, in turn, operates a small oil valve. This admits oil under pressure to the power cylinder. The power cylinder is directly connected through levers and a link to a rotary throttle valve fitted to the steam inlet of the engine. As this valve closes, it throttles the steam, thereby reducing the speed of the engine. The arrangement of the levers is such that when the power piston moves the oil valve is brought back to its mid position, thus allowing the power piston to stay in any position, according to the gas demand between a predetermined maximum and minimum speed. The spring which is attached to the gas piston, can easily be adjusted by hand, whilst the compressor is running to give any desired outlet pressure.

In addition to this slowing-down governor, the engine is fitted with the makers' standard shaft governor acting directly on to a double-seated throttle valve for controlling the maximum speed of the set. The outlet governor, fitted to the gas compressor, is operated from a relay and comes into operation when the slowing-down governor has reached its minimum speed. This governor totally unloads the compressor by passing the gas from the delivery to the suction side. This form of combined governing ensures the economical operation of the plant under all conditions of operation.

Besides such plants as that just described, which we noticed going through the shops, there were a number of simple two-cylinder steam engines, ranging up to one or two hundred horse-power, and we were curious about their prevalence in view of the popularity of oil engines for such outputs. We learned that they were mostly intended for working against a back pressure in the exhaust at factories where a supply of steam is required for process work. The effectiveness and efficiency of the reciprocating steam engine for such services is, of course, well recognised, but



STEAM ENGINE AND GAS COMPRESSOR



SECTIONAL ARRANGEMENT OF STEAM ENGINE AND 5000 CUBIC METRES GAS COMPRESSOR UNIT

the following notes may be of interest as showing the extent of the economies which can so be made.

The oil engine has held a high place in economical power production due to fuel economy and lower capital costs over a steam plant where the boiler house and chimney is included in such costs. In the case of back-pressure engines, the boiler equipment is in most cases already installed, and the steam can be generated at a higher pressure for a very little additional cost. With this comparison the oil power plant loses both the advantages of fuel economy and lower capital costs.

With Diesel fuel oil at £5 5s. per ton, including tax (4d. plus 1d. tax, 5d. gallon), with coal £1 per ton, and at 18,000 and 12,000 B.Th.U. per 1 lb. higher and lower value respectively, the thermal value of the fuel per penny is 32,000 and 112,000, or in the ratio of 1 to 2·86 in favour of coal fuel from a calorific point of view. The question of wages is always a debatable point, as the steam plant is usually debited with attendants in both the boiler and engine room.

The efficiency of a high-class oil engine on full power factor would be 36 per cent., which corresponds to a fuel consumption of 0·39 lb./b.h.p./hour. The overall efficiency of a steam plant for equal fuel costs would require to be 12·6 per cent.

With a modern condensing engine using average steam conditions, *i.e.*, 200 lb. boiler pressure, 200 deg. Fah. superheat, and 26in. vacuum, the efficiency of the boiler plant would need to be 72 per cent. to equal the oil power plant. Such a boiler efficiency can be obtained on test, but does not cover banking, inefficient firing and damp coal. It should be remembered, however, that relatively small quantities of steam for heating and power purposes can be generated from the exhaust of internal combustion engines.

Steam engines can be arranged to operate without cylinder oil lubrication where steam, free from oil, is required for special process purposes. Such engines operate very satisfactorily on saturated steam, and while limited on the higher superheats can be made to run well on low superheated steam. Where the superheat conditions are too high, an oil separator can be fitted in the exhaust main to remove most of the oil which exists in the steam and ensure a minimum of oil being present in the process work steam.

It is important in back-pressure engines that they should operate at or near full load. If the graph appended giving the percentage of full-load steam is examined, it will be seen that the total quantity of steam increases for the lower loads as the back pressure increases. In considering different types of installations with regard to the utilisation of exhaust steam, the following cases may present themselves :—

(1) Where the demand for process steam and the demand for power as taken from the curve balance each other.

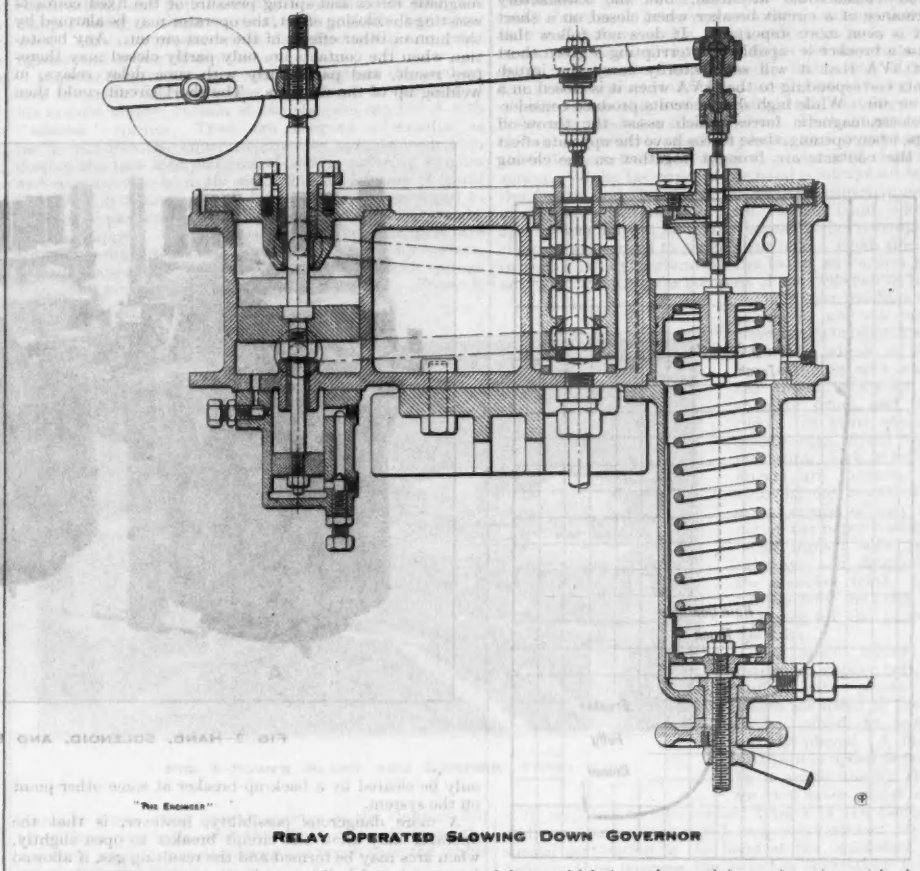
(2) Where the demand for process steam is greater than the steam exhausted by the engine when carrying the full-power load for mill and factory.

(3) Where the demand for process steam is less than would be given off by a back-pressure engine of such capacity as would meet the power requirements.

The cases (1) and (2) can usually be covered by a plain back-pressure engine. The additional steam required to make up any process steam could be taken direct from the boiler through a reducing valve.

For case (3) an extraction engine can be utilised.

The graph which we reproduce gives in a very convenient form the characteristics of back-pressure engines. Taking



RELAY OPERATED SLOWING DOWN GOVERNOR

as an example an engine working with a steam pressure of 150 lb. per square inch, a back pressure of 30 lb., and a demand for 12,000 lb. of process steam per hour, it is required to ascertain the b.h.p. of the engine and steam consumptions at one-fourth, one-half, three-fourths, four-fourths and five-fourths loads.

In the graph on the upper part of the vertical ordinates the steam pressure is given from 50 lb. to 250 lb. per square inch gauge. There is also illustrated a series of curves giving the back pressures which are read in conjunction with the steam pressures.

In the graph on the lower part, the vertical lines denote lb. of steam per hour, and the angle lines denote the b.h.p., which is to be read in conjunction with the line giving the lb. of steam per hour.

For the purpose of estimating the steam consumption per hour to loads other than full load, the graph has two other terms added, in which the vertical line indicates the percentage and full-load steam and the horizontal lines the loads on the engine, *i.e.*, one-fourth, one-half, three-fourths, four-fourths, and five-fourths.

Now reading horizontally across the 150 lb. gauge pressure to the curves of back pressure of 30 lb., and then downwards vertically until the horizontal line reads 12,000 lb. of steam, it can be read on the angle lines that the engine would develop 335 b.h.p. at normal load. From the percentage of full load steam lines for 30 lb. pressure, read :—For one-fourth load, 0·54 per cent.; for one-half load, 0·69 per cent.; for three-fourths load, 0·84 per cent.; for four-fourths load, 100 per cent.; for five-fourths load, 1·26 per cent. The steam consumption then per hour is as follows :—one-fourth, 6480 lb.; one-half, 8280 lb.; three-fourths, 10,800 lb.; four-fourths, 12,000 lb.; and five-fourths, 15,120 lb. per hour.

A few examples will make the chart easy to read, and should cover almost all the conditions in present practice for back-pressure engines of this design.

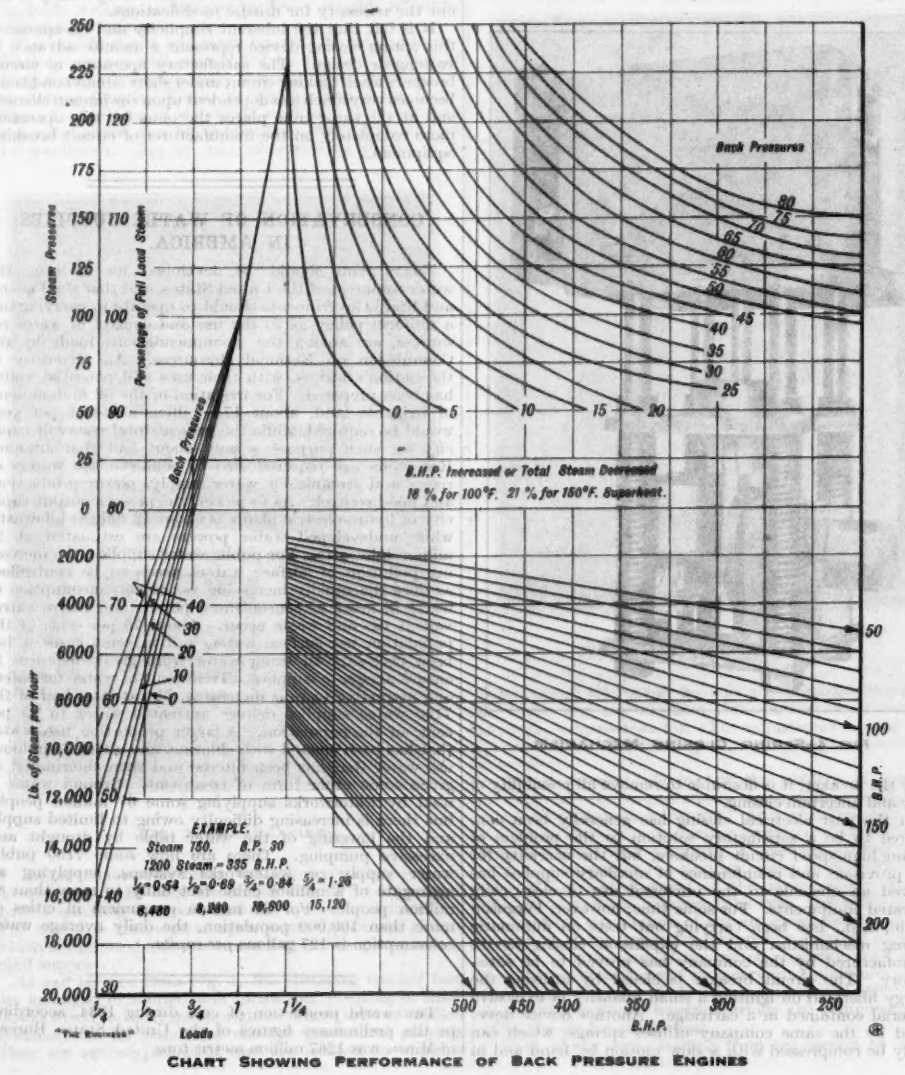


CHART SHOWING PERFORMANCE OF BACK PRESSURE ENGINES

FOOLHARDINESS IS NOT COURAGE.*

"BUSINESS is on a strike." "Business lacks the courage to go ahead." "Timid business men are obstructing recovery." This is the pæan of pain which arises from Washington during the intervals between the dirges which damn business men for having displayed too much courage and initiative in the past.

Does business lack courage? That depends on one's interpretation of the word. Foolhardiness is not courage.

One does not demonstrate the possession of courage by stepping at night into the depths of a jungle infested by strange animals that seem anxious to eat him up. Rather, he may prove his good judgment by waiting until daylight shows him the nature of their teeth and claws, if any.

Business is now confronting a jungle filled with strange animals, the like of which have never been known before.

There is the spendapotamus, who haunts the marshes of the Potomac and whose mouth is so big that it can gobble a billion dollars at one bite.

Then there is the radiocerous, who charges through the air to gore his victims.

And there is the investigator, a scaly creature who throws mud with his tail and delights in soiling clean reputations.

Also, there is the reformostrich, a clumsy bird, who runs about upsetting business men of all kinds unintentionally, and there is the pink-eyed destroyostrich, who does the same thing, but with malice aforethought.

These are a few of the many strange and terrifying animals which the American business man sees, not merely in his dreams, but also during his waking moments.

Courage? With all of these ominous creatures about, the American business man must have had plenty of it to venture as far as he has! J. H. VAN DEVENTER.

* *Iron Age*, April 4th, 1935.

New Spring Closing Circuit Breaker Mechanism.

DURING the past few years the subject of circuit breaking and the phenomena associated with arc interruption have received considerable attention, but the satisfactory performance of a circuit breaker when closed on a short circuit is even more important. It does not follow that because a breaker is capable of interrupting a given short circuit kVA that it will satisfactorily carry the inrush currents corresponding to that kVA when it is closed on a short circuit. While high short circuits produce considerable electromagnetic forces which assist the throw-off springs, when opening, these forces have the opposite effect when the contacts are brought together on the closing

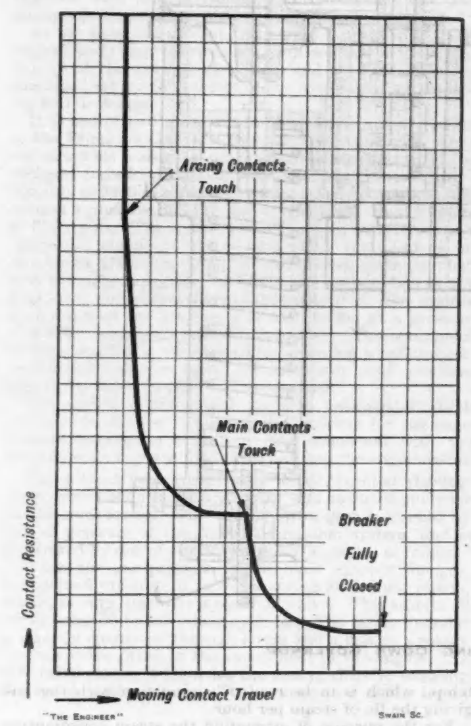


FIG. 1—CONTACT RESISTANCE CURVE

stroke. In other words, the final movement of the contact bar is resisted by the electromagnetic forces.

The contact area and pressure are initially considerably less on closing than when all the contacts are in the fully home position, the main contacts then being in parallel with the arcing contacts. The curves, Fig. 1, show the resistance of the circuit breaker contacts from the point of touching to the final home position, while the typical oscillogram of short circuit current—Fig. 2—shows that when a breaker is closed on a short circuit it must carry higher values of current than when it is breaking the circuit, and these higher currents have to be carried before the contacts have attained the minimum resistance position. The tendency towards overheating and welding of the contacts is therefore very much greater when

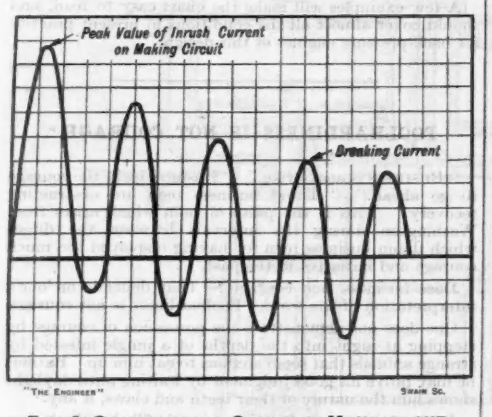


FIG. 2—OSCILLOGRAM SHOWING MAKING AND BREAKING CURRENTS

closing than when opening, with the result that, although a breaker may operate satisfactorily during breaking capacity tests, welding of the contacts may occur when it is closed on a short circuit. When opening a circuit, the fixed and moving contacts are mutually supported during the time of maximum electromagnetic forces, which, as well as repelling the moving contact bar, also cause attraction and repulsion of adjacent bars and conductors. When closing under short circuit conditions, however, the moving contacts are not so supported, and there is a greater possibility of mechanical damage in addition to increased likelihood of contact chatter and welding.

To justify the short circuit rating of a breaker, it is therefore essential to establish its ability to make the circuit as well as to break it. It is also clear from the foregoing considerations that the transitional stage from the least possible contact in the breaker to the full contact position should be made as short as possible, and for this reason a breaker should always be closed quickly and without hesitation to meet the case of a fault existing on the circuit. When breakers are closed by hand this important factor is controlled by the experience and strength of the operator, and even with a breaker of conservative design it is possible to close the circuit so as to produce welding of the contacts after the point of make, if the closing movement is sufficiently slow. Unfortunately, there is usually a tendency to hesitate at this point because, apart from the electromagnetic forces and spring pressure of the fixed contacts resisting the closing effort, the operator may be alarmed by the hum or other effects of the short circuit. Any hesitation when the contacts are only partly closed may therefore result, and particularly with time delay relays, in welding up of the contacts. The short circuit could then only be cleared by a back-up breaker at some other point on the system.

A more dangerous possibility, however, is that the operator may allow the circuit breaker to open slightly, when arcs may be formed and the resulting gas, if allowed to persist until delay protective gear can operate to release the mechanism, constitutes a danger. Under these conditions the circuit would be broken with gas under pressure in the breaker tank, in addition to that formed as the result of the interruption of the arc. The policy of providing very strong tanks such as those of round construction minimises the possible damage, but, as with hand-operation, it is necessary for the operator to stand

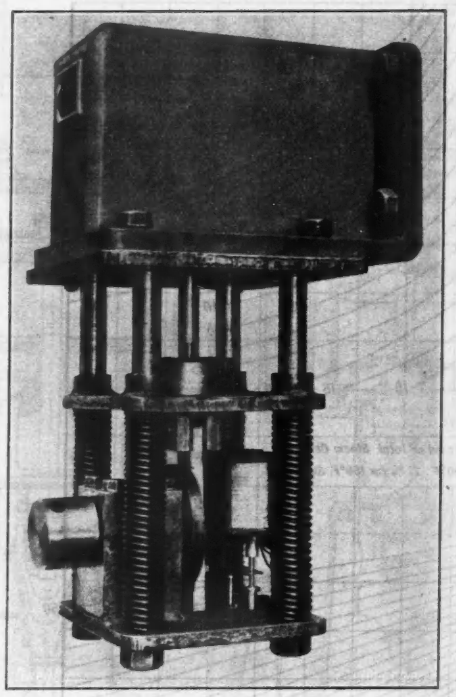


FIG. 4—SPRING CLOSING MECHANISM

near the breaker, it is desirable to remove all possibility of slow and uncertain closing.

In the past electrical closing has generally been considered to be a satisfactory solution to the problem of closing high-speed circuit breakers, but the necessity for the provision and maintenance of auxiliary supplies has proved an obstacle to the universal use of electrically operated equipments. For some time, however, Ferguson Pailin, Ltd., has been carrying out tests on automatic closing mechanisms, and the expansion closing device manufactured by the company has proved to be satisfactory. The circuit breaker is closed by utilising the energy liberated on igniting a small quantity of explosive material contained in a cartridge. Another device developed by the same company utilises springs, which can easily be compressed with a slow motion by hand and in which the energy so stored is utilised to close a circuit breaker smartly and without hesitation. The advantage of mechanism of this kind is, of course, that there is no necessity for a battery or other source of supply. The mechanism, which is shown in Fig. 4, consists of a carriage, which is made to compress springs by a toggle link, operated by the rotation of a shaft extending through the front cover of the mechanism and is actuated by means of a lever. The springs are compressed until the link is almost "on toggle," when a small roller latches the link in position. When the operating lever has been removed the closing spring mechanism is left fully "charged," but by actuating a small lever the energy is released to close the

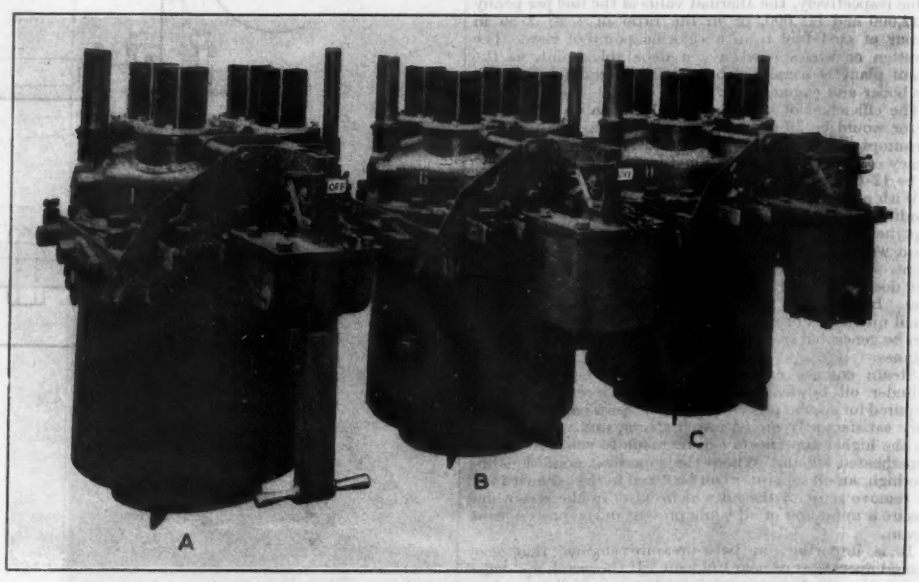


FIG. 3—HAND, SOLENOID, AND SPRING CLOSING MECHANISMS

switch at a speed quite independent of any endeavour on the part of the operator. Alternatively, if remote operation is desired, a small low-power release coil can be fitted, as shown in Fig. 4. The illustration Fig. 3 gives a comparison of the Ferguson Pailin spring closing mechanism with the hand and solenoid closing mechanism. The hand-operated, solenoid operated and spring operated mechanisms are shown at A, B, and C respectively. The spring-operated mechanism is housed in a compact case below the main mechanism plate and is comparable in size with the solenoid and hand-operated mechanisms. Each type of mechanism incorporates the same free handle chain closing device, which permits of interchangeability without the necessity for drastic modifications.

It is felt that the inherent simplicity and cheapness of this spring closing device represent a definite advance in switchgear design. The satisfactory operation of circuit breakers when making circuit under short circuit conditions becomes very much less dependent upon the human element and at the same time places the onus for this operation more completely on the manufacturer of circuit breaking equipment.

CONSERVATION OF WATER SUPPLIES IN AMERICA.

THAT plans should be developed for utilising the water resources of the United States, and that the Federal and State Governments should co-operate in carrying out a uniform policy as to the use and control of water resources, are among the recommendations made by the Commission on National Resources. An inventory of the nation's waters, with their uses and potential value, has been prepared. For irrigation of the 50 million acres of irrigable land, about 175 million acre-feet per year would be required, while the present total reservoir capacity for such purpose is only about half that amount. Reservoirs are required also to conserve the waters of rivers and streams for water supply, power production, and flood control. As to power, the present output capacity of hydro-electric plants is about 12 million kilowatts, while undeveloped water powers are estimated at 21 million kilowatts. For public water supplies, the increasing pollution of surface waters needs to be controlled, as does the rapidly increasing *per capita* consumption of water in areas of concentrated population, where extravagant use and waste occur. About 75 per cent. of the population use surface water, and in some cases it has been necessary to bring water from great distances to ensure adequate supplies. Treatment of water for safety and attractive taste is increasing, but at least half of the 7100 water supplies deliver untreated water to 25 per cent. of the population. A larger proportion uses water that has been treated with chlorine, and about 35 millions use water that has been filtered and then chlorinated or given some other form of treatment. Ground water is used by waterworks supplying some 67 million people, but there is increasing difficulty owing to limited supply and the lowering of the water table by drought and excessive pumping. There are now some 7100 public water supply or waterworks systems, supplying an aggregate of a million cubic feet daily to more than 80 million people. For 37 million consumers in cities of more than 100,000 population, the daily average water consumption is 127 gallons *per capita*.

THE world production of coal during 1934, according to the preliminary figures of the United States Bureau of Mines, was 1267 million metric tons.

Carillon and Clock.

THE constructional details of a modern carillon present many interesting advances over former practice, and it is particularly notable that many of these spring from the adaptation of devices, primarily designed for very different uses, to the special requirements of the carillon builder. In former times wooden frames, cumbersome claviers, inefficiently designed connecting wires and crankwork, and bad positioning of the bells made the task of the performer extremely difficult. In addition, the mechanical methods of playing were crude, usually relying

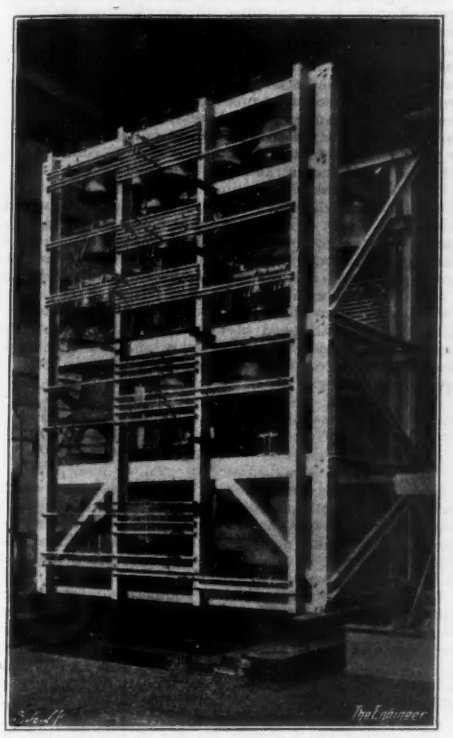


FIG. 1—MAIN FRAME

on a large barrel of the musical box type, provided with hundreds of cams, and driven by heavy weights requiring constant rewinding.

The modifications and improvements brought into use in late years are well exemplified by the new carillon of thirty-five bells which has recently been installed in St. John's Church, Perth, Scotland. The main frame (Fig. 1) is built up of structural steel, and is so designed that easy access can be obtained to every bell, and to the crankwork, clappers, and other moving parts. It is

FIG. 2—THE CLAVIER

of simple rectangular form, well reinforced by diagonal members, and the bells are bolted directly to supporting girders spanning the space enclosed by the outer members. The complete frame rests upon main supporting girders which are grouted into the tower walls, thus giving a very rigid support.

As can be seen from Fig. 1, the operating tracker bars are arranged in simple bank formation, pivoting in small blocks fitted to the frame uprights. There are two tracker systems, one for hand and one for mechanical playing. They are entirely separate, and are located on opposite sides of the frame. This method gives great simplicity of construction, and permits of the connections to each bell clapper being a single vertical and a single horizontal wire. All extra crankwork is dispensed with, and great lightness of action obtained.

In order to give an even touch throughout the carillon, and to enable the carilloneur to perform to the best of his artistic ability, certain of the clappers are fitted with "assister" springs. These are designed to equalise as far as possible the effort required to operate each key, despite the fact that clappers of widely differing weights and sizes have to be dealt with. The springs are of spiral form, and in the case of the smaller bells, are arranged to oppose the performer, thus increasing the apparent weight of the clapper. The middle register bell clappers are without springs, their touch being approximately correct, but the clappers of the larger bells are fitted with springs acting the reverse way to those of the smallest. Power is

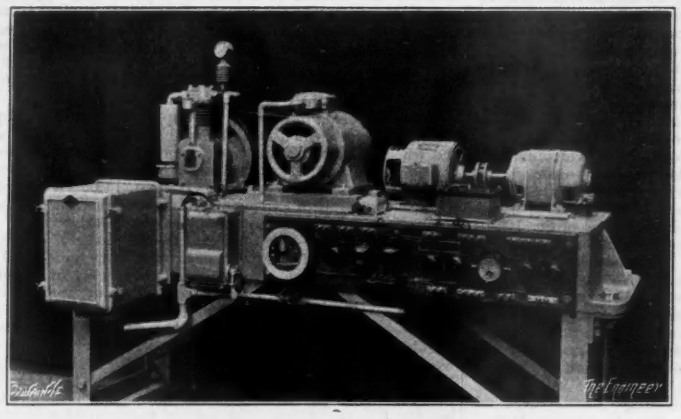


FIG. 3—POWER PLANT AND CONTROL PANEL

stored in these larger assister springs as the clappers fall away from the bells, and the effect is to decrease the apparent weight, thus equalising the touch over the whole range of the carillon.

The clavier (Fig. 2) conforms to accepted practice, but care has been taken with the spacing of the keys. The lowest twelve bells are also connected to pedals. A series of small screw buckles, permitting of fine adjustment of each connecting wire individually, is fitted above the clavier in easy reach of the performer. By the use of

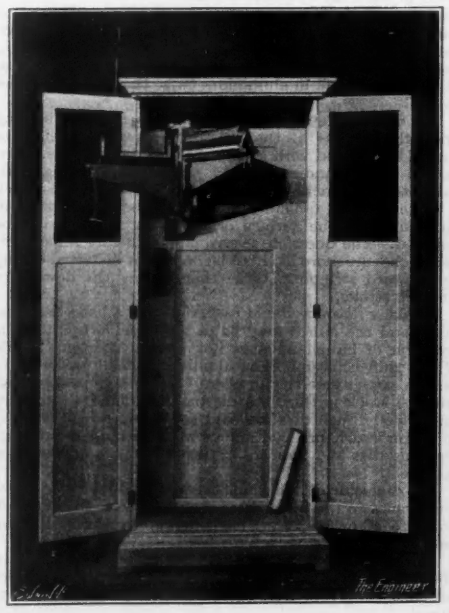


FIG. 4—THE PLAYER MACHINE

these, small alterations to suit the personal touch can be made, and any expansion or contraction of the connections compensated for. The adjustment can be made by the fingers, and small springs guard against accidental movement.

The mechanical playing of the carillon is operated through an electro-pneumatic mechanism possessing a number of interesting features. At a predetermined time, the tower clock trips a starting switch, completing a low-voltage circuit and actuating a solenoid-operated relay switch contained in the circular casing to be seen on the left of the control panel of the power plant (Fig. 3). This relay is of the mercury tube type, and when tripped it completes the circuits of the air compressor motor and the small motor generator, through a suitable contactor switch. The purpose of the motor generator is to supply the 20-volt direct current necessary for the circuits linking the electro-magnets of the piston valves and the contact fingers of the player machine, whilst the compressor provides the air for the pistons.

Each of the wires leading from the second or mechanically operated set of clappers on the carillon frame terminates in a pneumatic piston, the cylinder of which is controlled for air admission by one of the electro-magnetic valves previously mentioned. Air from the compressor is stored in the cast iron bases of the piston units, thus supplying the banks of pistons, as required.

The player machine controlling the valve circuits resembles a pianola in principle—see Figs. 4 and 5. A small fractional horse-power motor, driving through a belt and pulleys and a worm reduction gear, rotates a drum provided with sprocket teeth and transmits movement to an endless paper band. Below and slightly in front of the sprocket drum is a small contact roller, and at a point where they can normally make contact with this roller are located contact fingers. Each finger controls the valve circuit of one bell piston, and its contact with the roller is sufficient to bring the associated clapper into action. Whilst the paper of the band is interposed between the fingers and the roller, the circuit is interrupted, but when small perforations made in the band allow the appropriate fingers to make contact, the corresponding clappers are caused to strike their bells. From this it will be seen that by perforating the bands at various points, any melody within the compass of the bells can be played.

The player machine is contained in an oak case and consists of a massive A-shaped frame, to which is pivoted the swinging arm carrying the motor, reduction gear, sprocket drum, and contact roller. In front of this is a second arm, fitted with an insulating block on which the fingers are mounted. The swinging movement of these arms permits of easy changing of the paper bands, these being slipped into position sideways and dropped over the sprocket teeth, rows of perforations on the bands engaging for the purpose of the drive.

The small motor drives through a rubber belt, and a pulley with several steps allows the speed of the drum to be varied to suit any melody played. A final adjustment of speed is provided by a small sliding rheostat inserted in the motor circuit.

In addition to the contact fingers of the pistons, an additional finger is provided, and makes contact through a special perforation in the band at the conclusion of the melody, thus tripping the switches controlling both the power plant and the player machine.

A neat method is employed to ensure that the player machine does not start up until a sufficient pressure of air is available. In the centre of the control panel is a pneumatic cylinder, with a piston of the weight-loaded type, and above it a pair of contacts. The cylinder is connected to the compressed air supply, and the loading adjusted to prevent the contacts from closing until the correct operating pressure is attained. The contacts are included in the circuit of the player driving motor, and it is therefore impossible for the movement of the band to begin until the air supply is capable of actuating the pistons.

A system of assister springs, closely resembling those fitted to the hand-operated clappers, is coupled to the

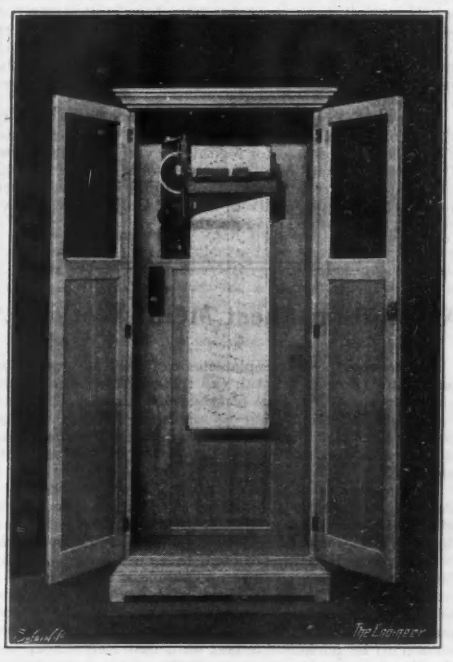


FIG. 5—PLAYER MACHINE WITH ROLL INSERTED

clappers of the mechanical action. As a result the mechanical playing is very even and without the inequality of sound and uncertainty of action sometimes so noticeable with carillon machines.

The quarter chiming unit of the tower clock, which also forms part of the new installation, has some interesting constructional details. The original weight-driven clock, indicating the time and striking the hours, has been retained, but the new unit for sounding the quarters in addition completes the equipment. It is motor driven and comprises suitable reduction gear and barrels for

carrying the chiming cams, the action being started up by contacts controlled by the timepiece. The chiming of the appropriate quarter and the tripping of the control switch then follows automatically.

The assembly of the unit is simple. The driving motor is mounted on a box bed and coupled to a worm reduction gear by a centrifugal clutch. This enables the motor to start up under "no load" conditions, a feature rendered necessary by the impossibility of using other than simple trip switches for motor control.

The worm reduction gear is totally enclosed and runs in an oil bath, whilst spur gearing is used for the two subsequent stages. The barrels take the form of two cast iron drums, into which the steel cams are inserted. Provision has been made for the use of the two interchangeable barrels alternatively, thus allowing of the Westminster or Guildford quarters being sounded at will.

The switchgear controlling the motor is of the enclosed tube mercury type, a solenoid being energised by the contacts closed by the timepiece and serving to trip the tube, which is pivoted out of balance, and close the motor circuit. As each "quarter" is sounded a count wheel provided with ratchet teeth is stepped, and at the appropriate moment this movement causes a pin mounted on the wheel to trip the motor switch back to its original position, breaking the circuit and stopping further action until the next tripping impulse from the timepiece.

The advantage of this unit system, which can be used for both chiming and striking mechanisms, is that the many former coupling wires and cranks can be eliminated, and the units placed closely alongside the bells, the timepiece remaining at any convenient point.

The bells forming the carillon have special claim to notice, for they are tuned on the true five-tone harmonic principle, a method which places the overtones and harmonics in tune with the strike note, and ensures that each bell is in harmony, not only with the other bells, but also with itself. Thirty-four of the bells are new, whilst the Bourdon is the old "Seven Hour Bell" of St. John's Church, cast in 1504 by Waghevens, of Malines, Belgium. For the purposes of the carillon it has now been carefully tuned on scientific lines and blends perfectly with the new bells. This was possible because the bell was not only a fine example of the founder's art, but was of unusually pure tone, with the overtones much nearer truth than is normally the case. Very little tuning was necessary and the work done has resulted in the achievement of absolute purity of tone.

The thirty-four new bells are hung "dead," or fixed, in the main carillon frame, but the old "Seven Hour" Bourdon is hung for ringing in a separate iron and steel frame and will be rung for services. Ball bearings of the self-aligning type have been used for the gudgeons of the headstock, in order to minimise the effort necessary for ringing. The fact that this bell is rung in addition to its use as the carillon Bourdon has necessitated a different form of clapper for both the hand and mechanical playing attachments. These clappers are similar to clock striking hammers and deliver their blows on the outside of the bell instead of the inside. In addition to these clappers, there is the hour striking hammer of the clock, and provision is made for lifting all three striking attachments clear of the bell when it is to be swung for ringing. The buffer spring of the clock hammer is of the coil type, being sunk in a socket in the hammer frame. This form has proved more reliable than the usual flat spring, being less liable to fracture.

Throughout the whole installation it has been borne in mind that maintenance of such mechanism must be simple enough to be carried out by a relatively unskilled person. To this end the various units have been grouped where possible. The motor generator, air compressor, contactor switch, control panel, fuses, &c., have been located on a box bed which is raised on girders to a convenient height. Very occasional lubrication and adjustment is the only work required. Attention to the player machine and the pneumatic pistons is equally simple and is mainly confined to lubrication.

The mechanical portion of the carillon plays a melody at suitable times following the striking of the hour, whilst the clavier will be used for recitals by various carilloneurs. The founding and constructional work as well as the installation and re-tuning of the Bourdon has been carried out by Gillett and Johnston, Ltd., of Croydon, who have supplied the photographs reproduced.

Aluminium Sheet Metal Working.*

Panel Beating.—The replacement of steel by aluminium panels does not, in general, call for any alteration in the plant lay-out or the type of labour employed. The same tools and machinery can be used for cutting, rolling, beating and planishing, and the skilled panel beater in steel will find aluminium easier to work because of its malleability.

The normal method of panel beating is as follows:—Patterns having been taken of the various panels, the aluminium is cut out of sheet with an allowance of about 1in. for the curved sections. For good quality work, No. 16 s.w.g. is used, although this may be replaced by No. 18 s.w.g. where little or no shaping is necessary.

The primary curve is obtained by rolling the panel section, and the secondary curves are worked in either by puckering or by sandbag beating. In the first method the section to be puckered is laid on a cast iron shaper and the aluminium is bent in towards the centre of the pucker. The bent portion is then beaten with a soft wooden mallet towards the highest point of the bend, and this has the effect of working the pucker into the sheet, giving a two-plane curve. At the same time the material is thickened and strengthened, the increase in thickness being at least 1 gauge size.

The alternative method is to beat out the panel on a sandbag, using a round-nosed mallet. Very light blows are struck, always on different points, and this method calls for highly skilled labour. This method, of course, spreads the metal instead of closing it up, and as a result there is a reduction of thickness and a certain weakening of the panel at a highly stressed point. For this reason the puckering method of panel forming holds certain advantages, since there is a strengthening of the stressed portion of the panel. During the final formation of the panel it is constantly fitted to the framework and any adjustment needed is obtained by judicious stretching or shearing of the metal.

The final panel shape being obtained by any of the above methods, the surface is restored by planishing either by hand or with a power hammer according to the curvature. Care is necessary here because of the softness of the metal, as unless it is struck squarely by the hammer ridges will be formed which will be difficult to remove. Finally, the panel is rolled between wheels with a shaped periphery, and the friction or rolling action produces a perfectly smooth surface.

Panel Wheeling.—Panels of moderate convexity can be raised to the required shape by wheeling. A wheeling machine, the construction of which is simple, is essential. The under wheel, 2in. to 3in. in diameter, runs free on a spindle carried by a vertical arm, the latter having a screw adjustment. The top wheel, 6in. to 8in. diameter, is fixed on a horizontal shaft, which is actuated by a lever. The wheels are usually convex, and meet at a common centre. The sheet to be raised is placed horizontally between the wheels, to a position representing approximately the centre of the panel. Pressure is applied from the bottom wheel. The pressure is of importance, and must be governed by the thickness and temper of the sheet. Excessive pressure will cause buckling; insufficient, produces little or no effect. The better way is to apply pressure lightly and increase it as required.

The sheet being in position the top wheel is actuated by the hand lever, which causes the sheet to move between the wheels. A backward and forward movement is continued, longitudinally and transversely, increased pressure being applied if necessary. The panel takes a convex form as the result of expansion from pressure. The operation is continued until the desired shape is attained.

Panel Pressing.—The tendency to simplicity of design, and the deletion of complex curvatures from motor body work, has opened the way to the production of panels by methods much more expeditious than by beating or wheeling. The power-driven percussion screw press is—with the use of suitable tools—capable of producing raised panels rapidly and at a fraction of the cost of hand-raised work. The surface of the metal remains smooth, reducing labour costs for finishing to a minimum. The ratio of pressure as between aluminium and steel is approximately 1 to 4; hence a saving on tools, machines, and power.

Press Work.

The remarkable ductility of aluminium is one of its outstanding properties, and due to this not only is the working of aluminium easier, but also shapes which are too complicated to be made commercially in other metals may readily be obtained with aluminium. The number of passes through the press required to produce a given size of cup in aluminium is exceptionally small. It is not unusual to draw in one operation from a flat blank of medium thickness a cup the length of which is equal to its diameter. Subsequent reductions in diameter may be made in a similar intensive degree.

Moreover, the power required for the processes is comparatively small. Power presses are usually listed according to their capacity when dealing with mild steel, and a useful rule to follow is to assume that any particular size of press will blank in aluminium twice the listed thickness of steel.

The dies employed have, of course, a material bearing upon the success of the pressing operation. The dies should be finished with great care and the surfaces maintained bright and polished. Aluminium, being soft, clings to the punch, and unless the surface of the punch is quite smooth, difficulty is likely to be encountered in stripping, and the surface of the work may possibly be scarified. The question of stripping is highly important, as punches are more likely to be broken or distorted during the upward stripping stroke than during the downward working stroke.

Blanking dies may be of cast iron with a hardened steel inset, and the punch may be of tool steel left soft. The omission of hardening does not unduly shorten the life of the punch, seeing that aluminium itself is soft. In certain cases where the number of blanks required is small and the stock is thin, the die may be made of ordinary mild steel. Such dies are said to be capable of seventy to a hundred hours' continuous work without retouching. Drawing dies and punches are usually made of hardened tool steel.

The diameter of the punch should be such as to allow a clearance in the die greater than the stock thickness, in order to allow for any thickening up of the cylindrical part of the cup.

A very smooth, hard, and regular surface may be obtained by passing the work through a pair of dies designed simply to iron the surface and not to alter its shape.

The use of a good lubricant is important. For deep drawing a cheap vaseline or lard oil is recommended, but for blanking, stamping, or shallow drawing, paraffin is quite suitable.

The lubricant should be applied to both sides of the blank, and also to the punch and die. The blanks can be rapidly lubricated by passing them between felt-covered rollers, the lower one of which dips into a bath of oil.

The reduction in diameter per pressing operation will be governed by the thickness of the metal and by considerations peculiar to the work in hand, but as a general rule one may assume that the diameter of a cup after the first drawing operation may be from 45 to 55 per cent. of the blank diameter. In subsequent redrawings the successive diameter reductions will depend not only upon the thickness of the stock, but also upon the amount of ironing. As an average, the percentage reduction in diameter per operation is 30 per cent. for metal up to $\frac{1}{64}$in. thick, 24 per cent. for $\frac{1}{32}$in. material, and 18 per cent. for $\frac{1}{16}$in. material. These figures represent average practice, and it is often possible to make even greater reductions than those indicated.

If the reduction at any one draw is too great, the variation of thickness up the wall of the shell may make it difficult to adjust the clearances for following draws, but if the shell is to be finished by spinning, the greater thickness towards the top is an advantage.

As a general rule, the radii on the bottom corners of the punch should not be less than about one-sixth of the punch diameter, while the radii over which the metal is drawn should be six to ten times the metal thickness.

Spinning.

Metal spinning, though not so extensively practised as formerly, is still an invaluable process on account of the cheapness of the chucks employed as compared with the high cost of press dies. Thus, where only a small number of articles is required, it will be more economical to produce these by spinning than by press drawing, even if the shape is simple, whereas if the object is of complicated re-entrant outline, the cost of press dies may be excessive, so that spinning would be recommended even when a comparatively large number of articles is required. Spinning equipment is simple and far less costly than a press, and at the same time the range of sizes which can be dealt with is much more extensive. Spinning, for example, may be done in blanks as large as 6ft. diameter in a cheap form of lathe, whereas the press required to deal with such sizes would be enormously costly. Often also spinning is employed as an adjunct to the press, the press being used for producing the first shaping, and the more complicated working being done on the lathe.

The process consists in forcing, by means of hand tools, a sheet metal blank over a wood or metal former rotated at high speed in a lathe. The metal blank is held tightly against the rotating former or chuck by means of a wooden centre piece carried by the tailstock of the lathe, and the necessary pressure for forming is applied by a lever motion of the tool acting against a pin on the lathe rest.

With aluminium the speed of rotation should be very high, a peripheral speed of about 3000 linear feet per minute being employed. The following table gives the speeds appropriate for various sizes of chuck:—

Diameter of chuck.	Speed, r.p.m.
3in. to 6in.	2000
7in. to 10in.	1500
11in. to 14in.	1000
15in. to 20in.	500

For short runs the chuck is usually made of wood, beech being very suitable. Important work is better done on lignum vitæ or boxwood chucks on account of their hardness and good turning properties. Iron, or aluminium alloy, is used for chucks which are required to be of a more permanent nature.

The variety of work which a competent craftsman in aluminium spinning is capable of undertaking is comprehensive; indeed, the only factor which seems to limit his versatility is the necessity of devising a chuck which can be removed when spinning has been completed. Split chucks and other devices are used to overcome this, and it is even possible, though difficult, to spin "on air," *i.e.*, without a shaped chuck at all.

The spinner has a certain amount of control over the final thickness of his work, and, if desired, can arrange to thicken up those parts where most rigidity is required.

Before and during the spinning process, the blanks should be lubricated with vaseline, lard oil, or similar lubricant, applied with a rag or brush.

It is important in the interests of economy that the size and shape of blank employed shall be such that as little as possible has to be trimmed off when spinning has been completed. As in the case of press work, a rough rule is to take the area of the finished article as being equal to that of the blank. For complicated shapes, however, this gives a blank diameter which is somewhat too large, since during the spinning the parts which are worked the most are reduced in thickness, thus causing an increase in area.

* By permission of the British Aluminium Company, Ltd.

LAUNCHES AND TRIAL TRIPS.

San Arcadio, single-screw motor oil tanker; built by Harland and Wolff, Ltd., to the order of the Eagle Oil and Shipping Company, Ltd.; dimensions, 442ft. 6in. by 60ft. by 32ft.; to carry oil in bulk. Diesel engines, of Harland-B. and W. type; constructed by the builders; trial trip, recent.

Australia Star, motor vessel; built by Harland and Wolff, Ltd., to the order of the Blue Star Line, Ltd.; dimensions, 535ft. 5in. by 70ft. by 43ft. 3in.; to carry cargo and passengers. Diesel engines, Harland-B. and W. type; constructed by the builders; handed over after trial trip recently.

Hel, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Messrs. Zegluga, Polska, S.A., of Gdynia; dimensions, 243ft. by 36ft. 6in.; to carry cargo. Steam engines of compound reciprocating type, in conjunction with low-pressure exhaust turbine on Bauer-Wach system; constructed by the builders; a speed of 12 knots was obtained on trial trip, April 18th.

CATALOGUES.

Nichols Compressors, Ltd., Finsbury-pavement House, E.C.2.—Brochure giving particulars of rotary air compressors and exhausters.

Dorman, Long and Co., Ltd., Middlesbrough.—A booklet on foundry, hematite, and basic pig iron; also ferro-manganese and spiegeleisen.

Budenburg Gauge Company, Ltd., Broadheath, near Manchester.—Latest descriptive list of dial pressure gauges and gauge connections.

J. Browett-Lindley (1931), Ltd., Letchworth, Herts.—Catalogue of air and gas compressors, single and multi-stage, double-acting types.

Stockton Chemical Engineers and Riley Boilers, Ltd., Stockton-on-Tees.—A loose-leaf folder containing data sheets of chemical process plant.

English Electric Company, Ltd., Stafford.—The following publications:—R 27, "Three-phase Capacitor Motors for Power-Factor Correction"; R 34, "Lo-Ampstart Single-Phase Capacitor Motors"; R 47, "Neon Transformers"; R 10, "Danish State Railways, Electrification of the Copenhagen Suburban Lines"; R 35, "Modern Oil Circuit-breaker Design incorporating the De-ionising Method of Arc Control"; R 33, "Single-Phase Capacitor Motors"; R 43, "Direct-Current Machines, Class C A."

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Cartel Negotiations.

Business was not generally resumed after the Easter holidays until mid-week, and then the disturbing influence of the negotiations between the British and Continental steel makers was felt. The general impression was that the markets would not become active until the outcome of the meeting between the steel makers and the Cartel, which is to take place in London at the beginning of next week, is known. Reports of the discussions which took place in Brussels on April 16th are somewhat confused, and it would appear that there was almost a complete breakdown of the negotiations. So far as can be gathered the British steel makers offered a quota of 250,000 tons of semi-finished steel. This was rejected and a counter offer made of 643,000 tons of steel, including all the most generally used descriptions, and a reduction in the duties to the level of 33⅓ per cent. existing before the recent increase. This was the tonnage offered by the British to Continental steel makers at a meeting held some weeks ago. On this occasion, the British representatives were not prepared to accept the offer, and for a time it looked as though the meeting would be adjourned indefinitely. It was finally decided to meet again in London on April 30th, and it was understood that the British steel makers were to consult with the Government as to the attitude they should then adopt. Since the meeting the Continental steel makers have made no secret that they are preparing plans for an intensified campaign to secure business in the export markets unless an agreement can be reached with the British. They claim that just as the British steel makers have the British Government behind them, so the Continental Governments are supporting their own steel industries. Of course, such a campaign can only result in loss to all the industries taking part in it, and the general view of the market is that after much haggling an arrangement will be reached covering the British market and the world's export markets.

Pig Iron.

Although deliveries were suspended over the holidays the blast-furnaces continued in operation so that there has been some slight addition to the stocks of all kinds of pig iron. Business was resumed following the break, however, in rather brighter conditions, as several inquiries for contract renewals were circulated; but the greater part of the business transacted has been of a hand-to-mouth character. On the North-East Coast if the actual position has not altered, prospects have certainly improved. A few contracts were placed just prior to Easter for delivery up to the end of June, and it is expected that some substantial fresh business may be given out by Scottish consumers who have been negotiating with the North-East Coast makers. Although the stocks in this district have increased recently they are still well below normal, and are not causing the makers any anxiety. In the Midlands the position has changed little for some weeks, but is satisfactory inasmuch as the producers of pig iron are comfortably situated as regards orders on their books. Some of the light castings makers are working short time, and at the moment this industry is not providing an outlet for the quantities of iron it usually takes up during the spring months. In Lancashire consumers' requirements have been principally met by deliveries against contracts, but since the holidays some suppliers profess to see signs of a stronger demand. The textile machinists, who normally absorb a considerable amount of pig iron, are far from busy, and this has a noticeable effect in limiting the demand. Business in special grades of pig iron has kept up well during April, and there seems a good chance of requirements expanding in this direction. The hematite market has not shown much life since the holidays. Stocks in most districts in the country are fairly heavy, but, on the other hand, the producers have good contracts in hand and deliveries are being made on a satisfactory scale.

Scotland and the North.

Busy conditions developed in the Scottish iron and steel trade after the Easter holidays. The works resumed the heavy deliveries which were interrupted by the cessation of operations at the consuming works, and a fair amount of new business was placed. The quantities of shipbuilding steel required by the shipyards show little diminution, and locomotive makers have a fair amount of work in hand and lately have taken more interest in the market. Most engineering firms, also, are actively employed, and large tonnages of steel are finding an outlet in this direction, whilst railway orders will provide work for the mills for some time to come. Recently there has been some improvement in the volume of business with overseas markets, but most of these orders have come from other parts of the Empire, although some substantial contracts have been placed by the Soviet Government. The tube mills in Scotland also are busier than they have been for some weeks, partly as a result of an order from the Argentine, valued at £250,000. The re-rolling industry has secured a certain amount of new business as a result of the increase in the duties; but the improvement in their position has not been so noticeable as was anticipated before the advance was made. There are large stocks of Continental steel in Scotland, and, of course, the Scottish re-rollers have to compete with the unassociated British works. The result of these two influences upon the market is that some short time is still being worked by the re-rollers. A slight change for the better has been apparent lately in the black sheet trade, the home demand, which had fallen off somewhat, having revived. Export business in sheets, however, is still disappointing. In the Lancashire market the position this week has been much the same as that ruling before the holidays. The demand for most finished steel materials has been irregular, and consumers show a marked disposition to limit their orders to small parcels for prompt delivery. The Lancashire plate makers have been rather better off for business lately, and the time required for delivery has been expanded slightly. Constructional engineers in this district also seem on the whole well provided with work, but they are showing little disposition to place large forward contracts. This, however, may be due to the lack of confidence in the situation at the moment. The demand for special alloy steels, which showed a tendency to decline before the holidays, has improved again, and a fair business is also passing in bright drawn steel bars.

The Midlands and South Wales.

The Midlands have appeared latterly to be the most animated of the English markets for finished materials. In these days of artificial restrictions upon export trade, it goes without saying that the demand is largely upon home account, and the busiest section of the industry is that producing the lighter classes of steel. The re-rollers in the Midlands are benefiting from the increase in the duties, and although, like other departments, they have obtained little new business during the past week, it is expected that buyers of small bars and strip will re-enter the market so soon as the international steel situation becomes clearer. Most of the works have a good reserve of orders, and the chief complaint is that they have to compete keenly with manufacturers outside the Association. The latter have not advanced their prices of from £7 10s. to £7 12s. 6d. d/d Midlands as a result of the higher duties, although it is expected that they will probably do so in the near future. At present, however, there is a considerable margin between the associated and non-associated works' quotations since the former quote £8 12s., less a rebate of from 2s. 6d. to 5s. according to quantity. The constructional engineers in the Midlands continue to take a considerable tonnage of joists, angles and channels. Most of them expect to be busy for some months to come, and are likely to provide a satisfactory outlet for this description of steel. The plate manufacturers are not well off for work, and have experienced a scarcity of orders for the past few weeks. Business in boiler plates in particular has been quiet, although a fair tonnage of this material is passing into consumption against old contracts. The requirements of the home market for the lighter descriptions of plates and for sheets seem to have improved slightly of late, but it will have to develop considerably before it can be regarded as satisfactory. The demand from the collieries for steel materials is moderately good, and for steel arches has been maintained rather more than for other materials. Quotations are unaltered with light arches at £8, including fish-plates, nuts and bolts, and heavy arches at £9 5s. The activity in the South Wales steel industry has declined noticeably during the past few weeks, principally owing to the situation at the tin-plate works, which are experiencing a restricted demand. The production of steel for the first quarter of the year in South Wales averaged 22,700 tons per month, compared with 25,000 tons for the corresponding period of last year.

The North-East Coast and Yorkshire.

The market reopened after the holidays on a somewhat subdued note. None of the adverse factors which were operating before Easter have been removed. The threat of increased competition as a result of the fall in the Belga and the possibility that the failure of the British and Continental steel makers to reach an agreement at the Brussels meeting may lead to something in the nature of a price war, have exercised as strong an influence upon the market as before the break. Although new business is likely to be held back until the result of the next meeting of the British and Continental steel makers, deliveries have been resumed and most of the works are in a satisfactory position as regards the orders on their books. The reserve of orders, however, has decreased during the past few weeks, and a greater volume of new business would be welcome. The shipbuilding industry on the North-East Coast has been in a depressed condition for some time. Few orders have been placed this year and the yards on the Wear and the Tees in particular are badly off for work. On the Tyne the shipbuilders are rather busier. There are anticipations, however, that some new contracts will be secured as the result of tenders which have recently been submitted. The position of the constructional engineering industry is favourable, since most of the works are busy on good contracts. As a result there has been a sustained demand for structural steel for some time. Business in semis declined suddenly after the recent burst of activity, and for the time being consumers appear to be content to watch the market. Although there was some falling off in the rate of operations in the Sheffield market before Easter, it was not sufficient to cause anxiety to the makers. Generally speaking, the present flow of orders exceeds the demand ruling at this time last year. Business in the basic steel section continues at a high level, but there is a noticeable decline in the demand for acid steel. The works supplying railway material are well off for orders, and some large contracts for tires and axles are in hand. Lately there has been a slight halt in the demand for special steels, and consumers' requirements of stainless steel have not been quite so heavy.

Current Business.

The shipyard of Workman Clark (1928), Ltd., has been acquired by National Shipbuilders Security, Ltd., under the scheme for closing down redundant shipyards. The property of the firm on the south side of the river has been acquired by Harland and Wolff, Ltd., who will use it to extend their existing engine shops. The north shipyard may be taken over by a newly formed company for the building of aeroplanes. The works belonging to the Metropolitan Cammell, Carriage Wagon and Finance Company, Ltd., at Nottingham, covering about 13 acres, has been acquired by Thos. W. Ward, Ltd., of Sheffield. A contract valued at three million pounds for the electrification of the Central Railway, Brazil, has been secured by the Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester. Sub-contractors will include the Metropolitan Cammell, Carriage Wagon and Finance Company, Ltd., Birmingham (passenger rolling stock), British Insulated Cables, Ltd., Prescott (cables), and the British Thomson-Houston Company, Ltd., Rugby (transmission equipment). The Burntisland Shipbuilding Company, Ltd., have taken an order from the Joseph Constantine Steamship Line, Ltd., for a coasting steamer of 1420 tons d.w. The propelling machinery will be supplied by the North-Eastern Marine Engineering Company, Ltd., Sunderland. The Department of Overseas Trade reports that the following contracts are open for tender:—Indian Stores Department; 30,000 fish bolts and nuts (Simla, May 2nd); superheater boiler flue tubes and boiler smoke tubes (Simla, May 7th); wrought iron or mild steel pipes and fittings to I.S.D. specification G/W.W–44–B (Simla, June 11th). Johannesburg City Council: Light tramcars and trucks (Johannesburg, June 1st); three-phase calibrating converter, suitable for a current supply of two or more three-phase meter-testing equipments, having a total output of 3×500 and 3×1000 ampères at 3×380 volts, 50 cycles (Johannesburg, June 15th). South African Railways and Harbours: Five battery elevating platform trucks with lifting capacity of 7500 lb. each (South Africa, June 17th). Melbourne City Council: Totally enclosed metal-clad switchgear for operation on a 6600-volt, three-phase, 50-cycle system (Melbourne, June 5th). Argentine State Railways: Axles and springs for rolling stock (Buenos Aires, June 5th).

Copper and Tin.

A good demand for electrolytic copper developed after the holidays. Consumers in most countries have been working on a small reserve, as there seemed very little prospect of prices advancing until the producers had reached some agreement. Now that a curtailment of output has been decided upon there has been a rush to cover forward requirements and, where possible, to lay in stocks. Buyers in several countries, however, have been unable to secure all the copper they wanted owing to the difficulty of obtaining the necessary exchange to pay for the metal. A large proportion of the demand was met by the American producers, who sold considerable quantities. In fact, it is suggested that the Americans are shipping important quantities of copper to Europe before their exports are limited to 8000 tons per month by the agreement which comes into force on June 1st. The market seems convinced that the restriction upon production and the limitation of American exports will have a decided effect upon the price, which is expected to rise to much higher levels so soon as supplies of electrolytic copper are less freely offered. In the London standard market profit taking has greatly reduced the bull account. The activity of the electrolytic copper market has resulted in a certain amount of hedging in standard copper. According to some authorities, the market at the moment looks as though it was ripe for a reaction, although this would probably be only a temporary movement. . . . American consumers of tin have resumed buying and some heavy tonnages were purchased just before and after Easter. On the other hand, the demand from the Continent has not been maintained. It is said that Continental consumers are not well covered and that the poorness of this trade is largely due to the damping effect upon business of political uncertainties as well as the difficulty in some countries in obtaining the necessary funds. Heavy premiums are still asked for brands and there remains a backwardation of £3 10s. to £3 15s. At the moment there are renewed complaints that the International Tin Committee has not used the Buffer Pool to ease the situation.

Lead and Spelter.

Firm conditions prevailed in the lead market before and after the holidays. The steady tone is chiefly due to the strong demand from consumers, the lead pipe and sheet makers being exceptionally busy. Some apprehension has been expressed that the devaluation of the belga may lead to price cutting by the Belgian makers of manufactured products, such as pipes and sheets. As the whole lead position is being reviewed, however, and a scheme is under consideration for altering the present *ad valorem* duty to a specific duty it is possible that the British pipe and sheet makers may ask for an increase in the duties upon manufactured descriptions. Another proposal which has been put forward is that the present Metal Exchange contract should be made ex warehouse instead of ex ship, similar to those used for copper and tin. American figures give the world's production of lead in February as 123,954 tons, compared with 124,479 tons in January. . . . Prices in the spelter market have been steady and the tone has improved in sympathy with the better feeling in other non-ferrous metal markets. It is reported that negotiations are proceeding between Empire producers, consumers, and the London Metal Exchange with a view to putting a scheme before the Import Duties Advisory Committee similar to that which is now being considered with regard to lead. The demand from consumers has been rather less active of late, but the Continental demand has been good and German consumers have shown an inclination to buy substantial quantities in cases where finance can be arranged.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only rom associated British Steelmakers: joists 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow	
	4 0 6 „ Sheffield	
	4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ⅜in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ½in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6 .. 7 15 0	0 to 8 5 0

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ⅜in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ½in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2 to 19/2.
Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/– to 5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, April 24th.

Copper—		
Cash	£31 2 6 to £31 5 0	
Three months	£31 11 3 to £31 12 6	
Electrolytic	£34 15 0 to £35 10 0	
Best Selected Ingots, d/d Birmingham	£35 10 0	
Sheets, Hot Rolled	£60 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9¾d.	9¾d.
„ Brazed (basis)	9¾d.	9¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£28 0 0 to £30 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9d.	9d.
„ Brazed	11d.	11½d.
Tin—		
Cash	£225 15 0 to £226 0 0	
Three months	£221 15 0 to £222 0 0	
Lead	£12 5 0 to £12 8 9	
Spelter	£13 1 3 to £13 7 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

Lanarkshire—	Export.
f.o.b. Grangemouth—Navigation Unscreened	13/– to 13/6
„ Glasgow—Ell	16/6
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/– to 14/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6 to 14/–
Unscreened Navigation	12/6 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/6
Secondary Steam	12/9 to 13/–

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 17/6
Northumberland, Newcastle—	
Blyth Best	13/9 to 14/–
„ Second	13/3
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	24/– to 26/–
South Yorkshire Best	21/– to 23/–
South Yorkshire Seconds	17/6 to 19/–
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

Cardiff— South Wales.	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

A New Commercial Plan.

FURTHER evidences of trade decay, and a recognition of its causes, have led the Minister of Commerce to prepare a new plan for dealing with the situation, and it is now being examined in view of commercial treaties that are to follow upon the provisional arrangements recently entered into with Belgium and Italy. The Minister's visit to Brussels showed the necessity of France carrying out her obligation under the gold convention to provide increased trading facilities with the gold group, and the awkward situation created by the reprisals from Italy has been satisfactorily adjusted, as was the case with Belgium, by that country taking wheat from France and supplying goods in return. Other serious matters are the dwindling of foreign trade and the collapse of the tourist traffic, which is one of the most important sources of national revenue and affects the prosperity of the whole country. There can be no further delay in finding a way out of a dangerous situation. It is hoped that this will be done by the new plan, about which little is known except that the system of import quotas will be modified with a view to its ultimate suppression, and when quotas disappear prospects of trade recovery will become brighter. References to the plan by the Minister of Commerce would seem to imply that it is an elaboration of the one for developing trade within the gold group that could not be made operative on account of the impossibility of offering preferential treatment. It will be applied to all countries with which France has satisfactory commercial and political relations. Evidently the disappointing result of attempts to do anything with countries that hinder exchanges by putting an embargo on the export of capital suggests to the French that it would be better to offer facilities to countries that do not impose such restrictions. At the same time, if the new plan is based on preferential treatment, and returns to the original French idea of suppressing the most-favoured-nation clause, it is not likely to meet with general acceptance, though there may be much in it that is suitable to new trading conditions.

Armament Engineers.

The supervision of work on State orders in armament factories is undertaken by engineers drawn from different army corps and mainly from the Ecole Polytechnique and the Ecole Centrale. There are eighteen such factories employing normally 15,000 hands and 180,000 in time of war. There are, besides, engineers who are entrusted with the task of mobilising works and factories in particular areas, and altogether a considerable number of them are required to supervise armament production throughout the country in time of war. It has been found necessary to reorganise these engineers into a special corps, with conditions for admission which include several months' practical work in an armament factory and instruction at the Ecole Supérieure des Fabrications d'Armaments.

Streamlined Trains.

The P.L.M. Railway Company has been carrying out experiments with a view to accelerating services between Paris and the Riviera, and so far as rail-cars are concerned it has settled upon the oil-electric type, a number of which have been ordered, some with electric motors on the axles and others with single motors transmitting to the axles through gears. The cars are intended to run without stopping between Paris and Nice. At the same time, streamlined trains are being tried between Paris and Lyons, and last week a first run was made with an "Atlantic" locomotive and three metallic coaches, the whole being streamlined, with an apron extending down to within a few inches of the rails and panels between the coaches. The distance of 318 miles was covered in 4 h. 56 min. The highest speed attained was 90 m.p.h. There have been other occasions on which steam locomotives have exceeded the legal maximum speed of 74½ m.p.h., and the publicity given to the new performance implies that the limit which was fixed by law more than sixty years ago, and is regarded as a serious bar to progress, may, in the future, be more honoured in the breach than in the observance.

Wage Complications.

A complicated situation has arisen in industrial districts on the Belgian frontier which is crossed every day by thousands of Belgian workers employed in French works and factories. As the result of the belga devaluation of 28 per cent. some French employers reduced the wages of Belgian hands by 20 per cent., and this was resented not only by the Belgians, but also by the general body of French workers, who feat that this may lead to a reduction of their own wages. There have been strikes in some works, and employers affirm that the saving effected by the cut in wages of Belgian hands will be paid into a fund to be set off against production costs, which will thus be cheapened and the improved volume of business through lower selling costs will be to the advantage of everyone concerned.

Foreign Trade.

The returns of foreign trade during the first three months of the year show that imports were valued at 5140 million francs, representing a decline of 1242 millions as compared with the corresponding quarter of 1934; while the value of exports was 4058 million francs, a reduction of 455 millions. There were decreases in value all round, notwithstanding increases in volume, except of imports of manufactured goods and "material necessary for industry." An increase of 595,578 tons in exports was accompanied by a fall in value of 455 million francs, which is accounted for largely by the tonnage of wheat on which bounties are paid and by the inclusion of ships sold abroad in "material necessary for industry." The colonies and Protectorates were responsible for 28 per cent. of the total value of exchanges. The value of exports during March was the lowest recorded for some years.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

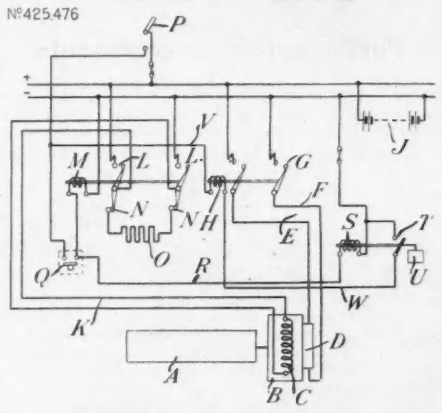
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

425,476. September 11th, 1933.—ELECTRIC STARTING SYSTEMS, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and C. W. Saunders and G. Ellis.

It is usual in the electric starter motors for internal combustion engines to complete the circuits through the field and armature simultaneously, with the result that, owing to there being an appreciable delay before the field is fully excited, a heavy current flows through the armature without producing a correspondingly large torque during this delay. Consequently, an excessive charge is removed from the battery. According to the invention, means are provided for preventing or limiting the current flow through the armature until the field excitation is sufficient to provide the necessary starting torque. In the drawing the internal combustion engine A drives the D.C. shunt-wound generator B having a shunt field C and an armature D. The armature is connected over lines E F, and through the contacts G of a contactor having a closing winding H to the bus-bars. Across the bus-bars is arranged to be connected a battery J. The shunt field C of the generator B is connected over lines K through the contacts L L of a contactor, having an operating winding M and normally closed contacts N making a circuit through a discharge resistance O across the bus-bars. The circuit to the coil M is arranged to be made from one bus-bar

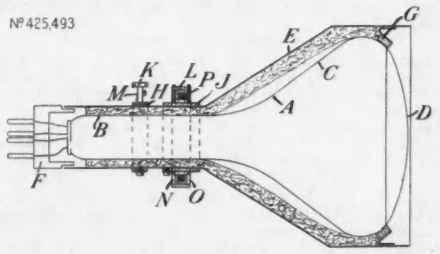


through a fuse and an interlock contact P, and a press button switch Q to the other bus-bar. On depression of the press button switch a parallel circuit is also completed over line R through the coil S of a contactor, having normally open contacts T and associated therewith time delay means U, which ensure that the contacts T close after the expiration of a predetermined time from the energisation of the coil S. The closing of the contacts T completes a circuit through the coil H of the armature contactor over lines V W. Assuming now that the plant is shut down, to start up, the various auxiliary circuits being made and the interlock contact P being closed, the press button Q is closed. The circuit to the coil M is closed and simultaneously the circuit through the coil S is also closed. The contactor then closes immediately and the generator field is energised from the battery J over the bus-bars and contacts L L. The generator field then builds up and the time delay given by the time delay means U is such that the contacts T do not close until the generator excitation has attained substantially its maximum value. On closure of contacts T the coil H is energised to close contacts G. The armature is then connected across the bus-bars. The generator then acts as motor and brings the internal combustion engine A up to firing speed. The time delay device may be of any known form, but is preferably of the mechanical trains of wheels type.—*March 11th*, 1935.

ELECTRICAL APPLIANCES.

425,493. November 6th, 1933.—ELECTRICAL DISCHARGE DEVICES, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and L. C. Jesty, Research Laboratories of the General Electric Company, Wembley, Middlesex.

This invention concerns cathode ray tubes used in television, and aims at preventing the adjustments being interfered with by the user. A is a cathode ray tube of the ordinary type having a tubular portion B, in which the ray is produced and deflected, and a conical portion C connecting B to the screen D. E is a metal casing of the same general form as the tube. One

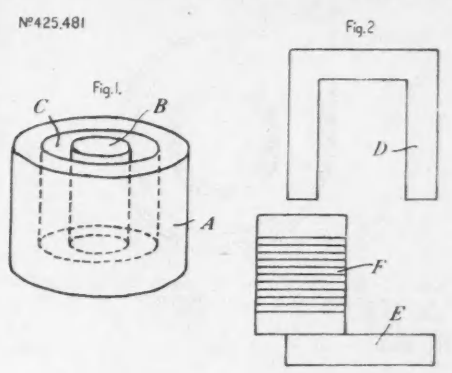


end is closed by the cap F carrying the terminals. The other is open to admit the tube. The tubular part B is located in E by packing, for example, of felt. The conical portion is located by a ring G with rubber facing inserted after the tube and clamps it permanently in position. The tubular part of the casing carries two sleeves H J, which, in turn, carry the magnets K L. K is a small permanent magnet intended to centre the ray in the tube; for this purpose it can be rotated about an axis M. L consists of two annular pole pieces N O, about which are wound magnetising coils P. These pole pieces form a magnetic lens, concentrating the rays. The pole pieces N O can be adjusted to be concentric with the tube by moving them relatively to the sleeve J. Both sleeves can be moved along the tubular part. After the adjustments have once been made, they are locked (for example, by soldering), so that they cannot be moved by the user.—*March 15th*, 1935.

TELEGRAPHS AND TELEPHONES.

425,481. September 14th, 1933.—VARIABLE INDUCTANCES AND VARIABLY TUNABLE CIRCUITS INCORPORATING THE SAME, Telefunken Gesellschaft fur drahtlose Telegraphie m.b.H., 12/13, Hallesches Ufer, Berlin, Germany.

A possible method of tuning radio receiving sets consists in employing fixed condensers and varying the inductance of the circuit. Now the condition to be satisfied if the oscillating circuit resistance and therefore the amplification is to remain constant is that $\frac{L}{RC}$=constant, where L is the inductance, R the resistance, and C the capacity of the oscillating circuit. Thus with the fixed condenser tuning system the ratio $\frac{L}{R}$ must be constant, and this is also the condition for constant selectivity. This requirement is not satisfied when an ordinary known variometer is employed as the variable inductance, because with such a variometer the loss resistance increases with frequency. If, however, the variable inductance of a fixed capacity tuned circuit be constituted by an inductance coil having an air core and whose inductance is varied by pushing a body containing iron into its magnetic field, the loss resistance does not increase with frequency, because in order to reduce the oscillation frequency the inductance L of the coil is increased by pushing in the iron-containing mass and this increases the



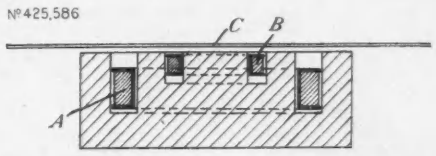
iron loss. It is therefore possible, by using such a variable inductance, to achieve the result that the ratio $\frac{L}{R}$ remains practically constant in the required tuning range, or at any rate only varies slightly. Experiments have already been made in this direction, using bodies constituted by a mass containing iron powder and it has been proposed to employ a core of the form shown in Fig. 1 of the accompanying drawings, which figure shows a hollow cylindrical ferro-magnetic pot A having an axial internal cylindrical column B, the coil (not shown) being movably mounted so as to be inserted to an adjustable extent into the hollow space C of this body. This arrangement has, however, the disadvantage that it is inconveniently heavy, and, further, there are difficulties of manufacture in connection with such a body of brittle material. The present invention provides a variable inductance in which these disadvantages are largely obviated, and according to it a variable inductance for tuning radio frequency circuits and comprising a coil or coils having a core containing magnetic material, is characterised in that the core is of a form (*e.g.*, of U shape) having a plurality of limbs connected by a yoke piece, at least one of which limbs is adapted to be inserted in a coil to increase its inductance, and comprises a co-operating closing piece also containing magnetic material, and which is adjustable in position relative to the limbs, the arrangement being such that in one extreme position a substantially complete circuit of magnetic material is provided for the coil or coils. Fig. 2 shows the variable inductance in the position of minimum inductance. On bringing the part D nearer to the part E the left leg of D (left, that is, in the figure) enters the coil F and the coil inductance increases.—*March 14th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

425,586. November 21st, 1934.—SYSTEMS FOR ELECTRICALLY MEASURING THE THICKNESS OF METALLIC WALLS, SHEETS, AND THE LIKE, A. Loewenstein, Beth Perlmann, Kerem Awraham, Jerusalem, Palestine.

This invention relates to an automatically operating electric measuring system which is suitable for measuring the thickness of metal sheets or metal walls as well as for finding unevennesses in the material of metal sheets, pipes, or other articles of metal.

The measuring device, which is extremely simple, both electrically and mechanically, essentially consists of two coils. One of these coils, acting as an induction coil, is connected to a source of alternating current having a constant root mean square value and having the frequency defined hereinafter. In the alternating field produced by the induction coil are positioned the second or measuring coil and the sheet or other thin metal article to be measured. The alternating field pro-



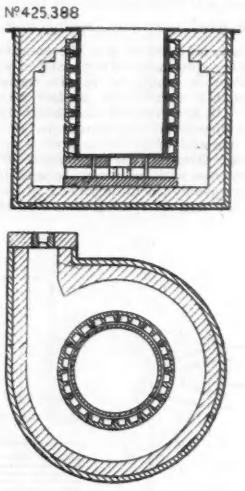
duces in the measuring coil an electromotive force which can be measured, for instance, with the aid of a voltmeter connected thereto. At the same time, the alternating field produces in the sheet an electromotive force which causes a circulating or eddy current to flow in the sheet. This current, in turn, produces an alternating field which weakens the primary field. Thus, the electromotive force produced in the measuring coil is modified. The amount of the change in the original field is dependent on the strength of the eddy currents, or, in other words, upon the electric resistance of the sheet along the path of the eddy currents and upon the permeability of the sheet material. For the same material the change in the field is thus only a function of the thickness of the sheet. This determines the relation between the thickness of the sheet and the electromotive force induced in the measuring coil. According to the invention, therefore, the position and size of the measuring coil, which is arranged on the same side of the sheet as the induction coil, are chosen in such a way that the measuring coil is influenced only by the effective flux, but not by the stray flux. To this

effect, the measuring coil is arranged coaxially with the induction coil and close to the sheet to be measured, and its diameter is made so small that it is threaded only by the central portion of the magnetic flux. The induction coil A and the measuring coil B are both coaxially arranged on one side of the sheet C to be measured. It will be seen that the measuring coil B is arranged at a short distance from the sheet and that its diameter is considerably smaller than that of the induction coil A.—*March 18th*, 1935.

FURNACES.

425,388. January 10th, 1934.—Annealing Furnaces, J. Howden and Co., Ltd., and W. H. Howden, 195, Scotland-street, Glasgow.

In order to protect the metal pot, in which articles to be annealed are heated, from the oxidising effect of the furnace

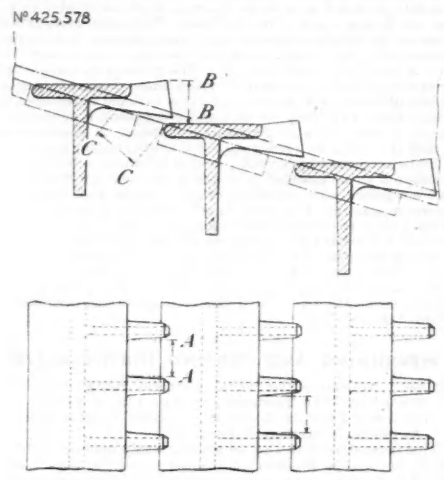


flames, the pot is surrounded by a jacket of refractory bricks. These bricks have tongues and grooves, so that they may be readily built up in place and are hollowed out on the inside to present as large a surface for the radiation of heat as is possible. The illustration shows an oil-fired furnace with a tangential burner.—*March 13th*, 1935.

CRUSHING AND GRINDING.

425,578. August 16th, 1934.—Coke Screens, West's Gas Improvement Company, Ltd., F. J. West, and E. West, Albion Ironworks, Miles Platting, Manchester, 10.

Coke is graded by being passed over a series of jigging T bars, arranged in stair-like formation. The object aimed at is to minimise the inclusion of long oversized pieces in the smalls. The bars are provided with projecting fingers which slope

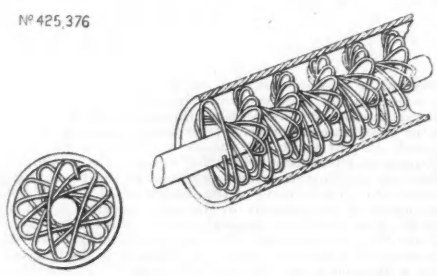


upwardly at an angle of 7½ deg. to the horizontal. The distance A A between the fingers is 1in. The distance B B from the top of the fingers to the top of the next T bar is $1^{5}/_{32}$in., and the distance C C, the shortest measurement between the two adjacent bars, is $1\frac{1}{16}$in. The difference between A A and B B and between B B and C C is consequently $^{5}/_{32}$in. in each case.—*March 18th*, 1935.

LIGHTING AND HEATING.

425,376. November 3rd, 1933.—Heat Transmitting Tubes, Clayton Dewandre Company, Ltd., and H. Blomeley, Titanic Works, Lincoln.

The inventors make a claim for:—A removable baffle for use in a heat transmitting tube consisting in a coil of wire

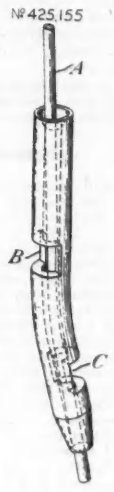


mounted around and fixed to a central rod or tube in such manner that the loops of the coil lie in a helical path, the whole forming a composite element of such dimensions as to fit closely within the heat transmitting tube. The drawing is self-explanatory.—*March 13th*, 1935.

WELDING.

425,155. September 13th, 1934.—Electric Arc Welding, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This invention relates to that form of welding known as metallic arc welding, in which the arc is maintained between a coated metallic electrode and the work. Referring to the drawing, the nozzle is provided with a curved passageway or conduit through which the electrode A is fed during the welding operation. By reason of the curved passageway, the electrode is forced into good electrical contact with the nozzle, as illustrated in the drawing. The nozzle is also provided with openings B and C extending in opposite radial directions from the passage- way and connecting therewith at the beginning and end of its curved portion. These openings are of sufficient size to discharge fragments of the surface coating of the electrode dislodged therefrom when passing through the nozzle. These openings are preferably located in such a position as not to interfere with the operation of inserting an electrode into the nozzle. It is for this reason that opening C has been placed opposite the portion of the curved surface of the passageway into which the end of the electrode is forced in its passage therethrough. The electrode delivery nozzle should be made of fairly hard material in order to withstand the abrading action of the electrode. It has been found that brass is a very satisfactory material out of which to make the nozzle.



When the nozzle becomes much worn by long use it may be readily replaced at small expense.—*March 7th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

To-day.

Chemical Engineering Group.—At Waldorf Hotel, Aldwych, W.C.2. Annual general meeting, 6.45 p.m. Annual dinner, 7.15 for 7.30 p.m. After dinner, address, "A Historical Survey of Wage Adjustments," the Rt. Hon. Lord Amulree.

Inst. of Electrical Engineers: London Students.—Savoy-place, W.C.2. Informal discussion. 6.30 for 7 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. "Recent Developments in Hydraulic Couplings," Mr. Harold Sinclair. 6 p.m.

Junior Inst. of Engineers.—39, Victoria-street, S.W.1. Informal meeting. General discussion on "Engineering Topics." 7.30 p.m.

North-East Coast Inst. of Engineers and Shipbuilders.—At Mining Inst., Newcastle-upon-Tyne. "Ship Collisions," Mr. H. E. J. Camps. 6 p.m.

Saturday, April 27th.

North of England Inst. of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Discussion: "Magnetic Observations on Concealed Dykes and other Intrusions in the Northumberland Coalfield," Prof. Granville Poole, Mr. J. T. Whetton, and Mr. A. Taylor; "A Record of the Upper Carboniferous Non-marine Lamellibranchs from the Bates Sinking, Blyth, Northumberland," Dr. William Hopkins. Paper, "The Influence of Colloidal Graphite on Bearing Surfaces," Mr. H. Shaw. 2.30 p.m.

Monday, April 29th.

Inst. of Civil Engineers: Belfast and District Assoc.—Queen's University, Belfast. Annual general meeting. 6.30 p.m.

Soc. of Engineers.—At the Geological Society, Burlington House, W.1. "Modern Methods of Engineering Training," Dr. Herbert Schofield. 5.30 for 6 p.m.

Tuesday, April 30th.

Inst. of Civil Engineers.—Great George-street, S.W.1. Discussion, "The Laws of a Mass of Clay under Pressure," Mr. M. A. Ravenor. 6 p.m.

Inst. of Fuel.—At Chemical Soc., Burlington House, W.1. "Paper dealing with "The Production of Comparatively Ash-free Coal," M. Maurice F. Bertrand. 6 p.m.

Wednesday, May 1st.

Inst. of Electrical Engineers: Wireless Section.—Savoy-place, Victoria Embankment, W.C.2. "Asymmetric Side-Band Broadcast Transmission," Mr. P. P. Eckersley. 5.30 for 6 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Annual meeting. 5 p.m.

Soc. of Glass Technology.—At Messrs. Holophane, Ltd., Elverton-street, Westminster, S.W.1. London Section meeting. 7.30 p.m.

Thursday, May 2nd.

Inst. of Electrical Engineers.—Savoy-place, W.C.2. Presentation of Faraday Medal to Dr. F. B. Jewett, of New York; twenty-sixth Kelvin Lecture, "The Molecular Structure of Dielectrics," Sir William H. Bragg, F.R.S. 5.30 for 6 p.m.

Inst. of Mechanical Engineers: Yorkshire Branch.—Visit to works of Thomas Broadbent and Sons, Ltd., Huddersfield; 2.45 p.m., Temperance Hall, Princess-street, Huddersfield. "Moving Bridges," Mr. F. W. Thompson. 6.30 p.m.

Friday, May 3rd.

Inst. of Electrical Engineers: N.-Eastern Students.—Annual general meeting.

Inst. of Mechanical Engineers.—Storey's-gate, St. James's Park, S.W.1. Discussion, "Progress in Design and Application of the Lysholm-Smith Torque Converter, with Special Reference to the Development in England," Dr. H. F. Haworth and A. Lysholm; "Voith Turbo Transmissions," Dr.-Ing. W. Hahn, translated by Mr. H. Sinclair. 6 p.m.

Junior Inst. of Engineers.—Hotel Metropole, London, S.W.1. Annual dinner.

Railway Club.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Railways in the Air," Mr. J. W. C. Logan. 7.30 p.m.

Royal Inst. of Great Britain.—Albemarle-street, W.1. Discourse, "Iron and Steel," Sir William Larke. 9 p.m.

Saturday, May 4th.

Inst. of Electrical Engineers: Meter and Instrument Section. Visit to Electrical Laboratories of Queen Mary College, Mile End-road, E. Leave I.E.E. Building, Savoy-place, W.C.2, 9.30 a.m. Leave Tower Pier at 1.30 p.m. for river trip to Greenwich.

Sunday, May 5th.

Royal Aeronautical Soc.—At Mr. Fairey's Aerodrome, Heath Row. Garden party. 2 to 7 p.m.

Tuesday, May 7th.

Inst. of Civil Engineers.—Great George-street, S.W.1. Presentation of Kelvin Medal, 1935, to Sir John A. Fleming, F.R.S., 5 p.m.; Forty-first James Forrest Lecture, "Geophysics," Prof. O. T. Jones. 6 p.m.

Wednesday, May 8th.

Inst. of Metals.—At the Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Twenty-fifth annual May Lecture. "Atomic Arrangements in Metals and Alloys," Prof. W. L. Bragg, F.R.S. 8 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "Canals," Mr. W. H. Curtis. 8 p.m.

Wednesday, May 8th, to Saturday, May 11th.

Inst. of Structural Engineers.—Institution Conference in London.

Thursday, May 9th.

Inst. of Structural Engineers.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Modern Methods of Flat Construction," Mr. S. S. Snow; "Foundations in Bridges," Prof. C. E. Inglis. 10 a.m.

Friday, May 10th.

Inst. of Electrical Engineers: Scottish Centre.—In Hall of the School of Economics and Commerce, Bell-street, Dundee. The Faraday Lecture, "Electricity in the Life of To-day," Prof. E. W. Marchant. 7.30 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Mr. John Holloway will introduce discussion on "Machine Tools: Twenty-five Years' Development Demonstrated at the Recent Machine Tools Exhibition." 7 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse by Dr. C. S. Myers, F.R.S. 9 p.m.

Saturday, May 11th.

Inst. of Electrical Engineers: Scottish Centre.—Excursion from Dundee to Taymouth Castle Hotel *vid* Dunkeld and Aberfeldy. Leave Albert-square, Dundee, 9.15 a.m.

Inst. of Highway Engineers.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Annual meeting. 3 p.m.

Monday, May 13th.

Inst. of Electrical Engineers: Wireless Section.—Savoy-place, Victoria Embankment, W.C.2. "Considerations in the Design of a High-Fidelity Radiogramophone," Mr. W. J. Brown. 5.30 for 6 p.m.

Tuesday, May 14th.

Illuminating Engineering Soc.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Investigation on the Production of Light," Prof. Dr. M. Pirani. 7 p.m.

Wednesday, May 15th.

Inst. of Electrical Engineers: South Midland Centre.—Visit to Droitwich Broadcasting Station. 3 p.m.

Thursday, May 16th.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "The Evolution of the Industrial System in the Far East," Prof. A. F. Barker. The paper will be read by Prof. A. T. King. 8 p.m.

Friday, May 17th.

Royal Inst. of Great Britain.—Burlington House, W.1. Conversazione. 9 p.m.

Monday to Friday, May 20th to 31st.

British Industries Fair: Engineering and Hardware Sections.—Castle Bromwich, Birmingham. Daily except Sunday.

Tuesday, May 21st.

Inst. of Mechanical Engineers.—Visit to British Industries Fair, Castle Bromwich.

Wednesday, May 22nd.

Inst. of Electrical Engineers: South Midland Centre.—Visit to Droitwich Broadcasting Station. 3 p.m.

Friday, May 24th.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse by Mr. S. C. Roberts. 9 p.m.

Saturday, May 25th.

Inst. of Electrical Engineers: Wireless Section.—Messrs. Cable and Wireless, Ltd., have invited the members to visit (i) The Central Station, Electra House, Moorgate, E.C.2; (ii) the Wireless Station at Ongar, luncheon at Theobalds Park Hotel, Waltham Cross; (iii) Wireless Station at Brentwood. 9.30 a.m.

Thursday, May 30th.

Royal Aeronautical Soc.—In the Science Museum, South Kensington, S.W.7. Wilbur Wright Memorial Lecture and Conversazione. The Memorial Lecture will be read by Mr. D. W. Douglas. 9 p.m. to 12 midnight.

Tuesday, June 25th, to Saturday, June 29th.

British Waterworks Assoc.—Summer Meeting at Cambridge. For provisional programme see page 382, April 12th.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

Davy Brothers, Ltd., Sheffield, have secured a contract from the Government of the U.S.S.R. for a complete forging and rolling plant for the production of tires for railway wheels, having an output of 36,000 tons per annum. The machinery includes a 3000 tons press, roughing and finishing mills, marking and rectifying presses, charging machines, hydraulic pumps, and accumulator, &c.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Rhodes, Brydon and Youatt, Ltd., Stockport, inform us that their London office is now situated at 28, Victoria-street, Westminster, S.W.1. Telephone number, Victoria 5948.

Mr. A. H. Gilling, M. Inst. C.E., M.I. Mech. E., has been appointed manager of George Cohen, Sons and Co.'s second-hand machine tool department at Sunbeam-road, Park Royal, N.W.10.

Tecalemit, Ltd., Middlesex, has appointed Mr. C. H. B. Price to manage its publicity department. Mr. Price was previously in charge of the advertising of the Skefko Ball Bearing Company, Ltd., Luton, and before that was with Buck and Hickman, Ltd., London.